From:	Catton, Susan J -FS
To:	Nathan Hostetter
Cc:	Tamara_Smith@fws.gov; bagardne@ncsu.edu
Subject:	RE: Lynx Conference Call
Date:	Wednesday, December 02, 2015 11:05:47 AM
Attachments:	draft_lynx_season_summary_2015 M.Fernandes Comments.docx

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Thanks Nathan. We are looking forward to the call with you.

I asked one of our biologists who has a strong background in statistical analysis and modeling to take a look at the draft report and provide some thoughts. Attached are his comments. Some of his comments maybe more relevant if this were to be a publishable paper. However many relate directly to the modeling and analysis. I thought you might be interested in the feedback. We can talk more about it on Friday.

-Susan

From: Nathan Hostetter [mailto:njhostet@ncsu.edu]
Sent: Wednesday, December 02, 2015 8:56 AM
To: Catton, Timothy J -FS; Tamara_Smith@fws.gov; Beth Gardner; Ryan, Daniel C -FS; Grosshuesch, David A -FS; Catton, Susan J -FS
Subject: Re: Lynx Conference Call

Hi Everyone,

Conference call information:

Date: Friday, December 4
Time: 1pm (eastern)
Call-in number: 919-512-6307

Best,
-Nathan

Nathan J. Hostetter
Ph.D. candidate
NC State University
Department of Forestry and Environmental Resources
Campus Box 8001
Raleigh, NC 27695
P: 1-541-410-1453
njhostet@ncsu.edu

On Thu, Nov 19, 2015 at 3:46 PM, Nathan Hostetter <njhostet@ncsu.edu> wrote:
Hi All,

Let's plan for a conference call on Friday, December 4, at 1pm (eastern). Please let me know if this time slot no longer works for you. I'll email call-in information prior to the call.

Dave - Sorry, I have not been able to get a hold of you. I hope this time slot works. If not, give

me a call and we can discuss.

Thanks everyone.
-Nathan

Nathan J. Hostetter
Ph.D. student
NC State University
Department of Forestry and Environmental Resources
Campus Box 8001
Raleigh, NC 27695
P: 1-541-410-1453
njhostet@ncsu.edu

On Mon, Nov 16, 2015 at 4:05 PM, Nathan Hostetter <njhostet@ncsu.edu> wrote:

> Hi All,
>
> Doodle poll link to schedule a lynx conference call is below. It looks like a busy week, but let's see if one of these times will work.
>
> http://doodle.com/poll/7qviz7mfkbhhh57z
>
> I will send the the draft report later this week.
>
> Thanks!
> -Nathan
>
> ---
> Nathan J. Hostetter
> Ph.D. student
> NC State University
> Department of Forestry and Environmental Resources
> Campus Box 8001
> Raleigh, NC 27695
> P: 1-541-410-1453
> njhostet@ncsu.edu

Use of detection/non-detection survey data to estimate Canada Lynx occupancy in Superior National Forest and designated lynx critical habitat in Minnesota

DRAFT 2015 Annual report

November, 2015

Nathan J. Hostetter and Beth Gardner

North Carolina State University

Department of Forestry and Environmental Resources

Raleigh, NC 27695

My comments throughout this document are in gold text boxes.

In the box below is a summary of my suggested approach a re-analysis whose primary goal is to help inform how to best proceed with the lynx study.

M. Fernandes

Summary of suggestions on how to improve occurrence analysis for final draft

(1) Use a hypothesis testing approach where a candidate set of models is defined *a priori* with each model representing a plausible alternative explanation of the factors influencing lynx occurrence and detections rates. This analysis should focus primarily on questions to help guide future efforts

(2) Null models should be included for both occurrence and detection rates.

(3) Models should include additional habitat variables thought to influence lynx occurrence and detection.

(4) Additional non-linear response functions should be included, including a threshold detection probability model.

(5) If there is sufficient data (I have not looked at the data), a portion of the data could be used for the analysis and the remaining data could be used to test the occurrence and detection predictions based on the analysis.

I would be happy to help with the analysis and I hope that I have the opportunity to contribute further.

M. Fernandes

SUMMARY

The general purpose of this report is to analyze lynx detection/non-detection data collected during a pilot snow-tracking study during winter 2014-15 and to discuss the value of this analysis in the context of future study design and use of occupancy as a metric of interest. The pilot study accumulated >3,100 km of snow-tracking surveys and >390 lynx detections across Superior National Forest and designated lynx critical habitat. ~~Preliminary data indicated that survey effort and detection/non-detection data can be recorded as part of lynx monitoring efforts~~. Occupancy analysis of detection/non-detection data indicated lynx occupancy was associated with habitat characteristics (percent evergreen and percent water) and was highly variable across the study (range = 0.01 – 0.99 depending on habitat characteristics). Estimates of occupancy from this pilot study provide useful information on the distribution of a difficult to monitor threatened species and can be used to inform future study designs aimed at monitoring lynx occupancy or designing more intensive studies to estimate abundance.

INTRODUCTION

Canada lynx (*Lynx canadensis*; hereafter lynx) were listed as threatened under the U.S. Endangered Species Act in 2000. Superior National Forest, Minnesota, USA has implemented a lynx monitoring program to track lynx populations and gauge the effects of management actions. Results of this monitoring plan have confirmed the persistence of lynx in northeastern Minnesota. While these data provide important baseline information, not all individual lynx are detected, therefore statistical models are needed to correct for imperfect detection of lynx. To that extent, additional analyses are required to track population-level parameters such as occupancy or abundance.

Estimating population size can be extremely difficult for species like lynx that have large home ranges, cover large geographic areas, and are difficult to capture. In such cases, other metrics such as occupancy (MacKenzie et al. 2002) can be useful for (1) monitoring species range dynamics and (2) helping to inform study design for abundance surveys, while also requiring less intensive survey methods. In this report, we analyze lynx detection/non-detection data collected during a pilot snow-tracking study during winter 2014-15. The objective is to provide information to USFWS and USFS on the potential utility of occupancy as a metric of interest and the potential to inform future study design.

METHODS

Study Area

The study area included 22,475 km^2 of Superior National Forest and designated lynx critical habitat in northeastern Minnesota, USA (USFWS 2014; Figure 1). Short warm summers and long cold winters are typical for this region (McCann and Moen 2011). Vegetation consists of both boreal forests and Great Lakes forests dominated by pine, fir, aspen, and spruce (McCann and Moen 2011).

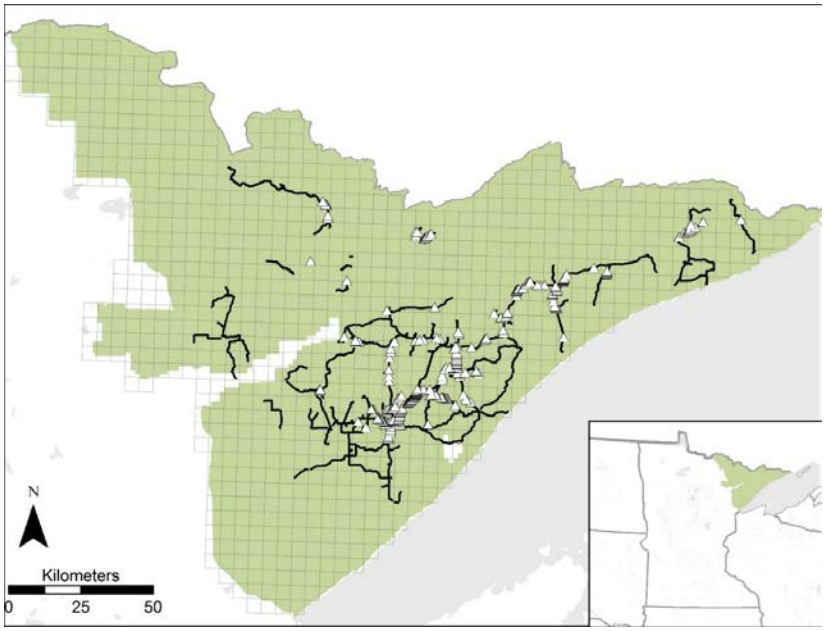


Figure 1. The study area encompassed the outer boundary of Superior National Forest and designated Lynx Critical Habitat in Minnesota (green). Survey routes are in black and lynx detections are shown as white triangles. The study area was divided into 5x5 km grid cells for analysis (grey grid).

Snow-tracking occupancy surveys

Snow tracking surveys (Squires et al. 2004) were conducted from November 2014 to March 2015 when snow cover was present. Trained observers drove open roads located throughout the study area recording the locations of all lynx sign (tracks or scat; Figure 1). Observers also recorded snow conditions during each survey as Good (≥3 days post snow, no blowing), Fair (1-2 days post snow, no blowing), or Poor (<1 day post snow or blowing snow) as snow condition is known to affect detection probability during snow tracking surveys (Whittington et al. 2014).

Methods – Additional information required
Description of survey methods needs additional information that is commonly provided for this type of survey:
(1) How were sites selected?
(2) How often were sites surveyed?
(3) If sampling intervals varied then provide basic descriptive statistics of sampling intervals.
(4) Provide basic descriptive statistics for survey route distances within 25-km^2 grid cells (e.g., mean and standard deviation).

M. Fernandes

Occupancy modeling

For analysis purposes we overlaid a 25-km^2 grid across the study area, resulting in 899 5-km^2 cells (Figure 1). Grid cells were selected to match other on-going surveys on Superior National Forest (NABat data provided by T. Catton; https://www.sciencebase.gov/catalog/item/546e65c5e4b0fc7976e4e894?view=folder). Only grid cells that were completely contained within the U.S. boundary were included as covariate values were not available for grid cells overlapping the U.S.-Canada border. A grid cell was considered surveyed if >0.5 km of a survey route occurred within the cell.

Methods – Additional information required
"A grid cell was considered surveyed if >0.5 km of a survey route occurred within the cell" Why? What is the justification for this sampling threshold? Given that route lengths differ, what is the average % sampled route equivalent of > 0.5 km? Without this information we have means of interpreting this threshold.
M. Fernandes

Temporal replicates were available for 129 cells that were surveyed on multiple occasions throughout the season (Figure 2). Essentially, this allowed us to consider each grid cell a 'trap' and generate encounter histories (detection/non-detection) for each cell based on whether or not lynx were detected during each survey.

Occupancy models have a hierarchical structure that uses the detection/non-detection information from replicated surveys to separate the underlying state process (i.e., occupied or not) from the observation process (e.g., the species was present but not detected during a survey).

Methods – Additional information required
"Occupancy models have a hierarchical structure" Occupancy models by definition do not necessarily have a hierarchical structure. Rather, the specific type of analysis employed here uses a hierarchical structure – meaning that the suite of occupancy and detection probability candidate models (whose relative support in the data is being compared) are less parameterized sub-models of their respective global models (i.e., the models that include all of the covariates being considered).
M. Fernandes

To analyze the snow tracking survey data, we used an occupancy modeling approach to estimate lynx occupancy (ψ) and detection (p), and to investigate possible covariate relationships (MacKenzie et al. 2002).

Methods – Additional information required
(1) Occupancy (ψ) and detection (p) need to be defined.
(2) Analysis assumptions need to be stated. In particular, it should be mentioned that this is a single season occupancy analysis that assumes that (a) the occupancy state at a site is assumed to remain constant throughout the season and that (b) repeated visits at a site are assumed to be independent samples
M. Fernandes

Methods – Additional information required
It is common, even in the ecological modeling primary literature, to provide a short paragraph explaining how this type of analysis works. Given that the background of this report's audience is likely to be especially diverse, it is all the more important to help your audience understand this report.
M. Fernandes

We included four habitat covariates on occupancy: percent evergreen forest, percent developed land, percent open water, and road density (km of roads per grid cell). Habitat covariates were calculated as the mean values for each grid cell, allowing each cell to have a unique value for each covariate. Habitat covariate data were obtained from the 2011 GAP Analysis [USGS] available at http://gapanalysis.usgs.gov/.

Data analysis – Model structure & inference
"We included four habitat covariates on occupancy: percent evergreen forest, percent developed land, percent open water, and road density"

The choice of models in this analysis is problematic.

(1) As in any analysis, we want to know whether the data being analyzed will allow for meaningful inferences to be made. In this type of analysis sample size alone does not answer this question. Null or "dot" models (*i.e.*, $\psi(.)$ and $p(.)$ models) can help us determine whether the models in the analysis adequately explain the processes influencing lynx occupancy and detections rates. There is no mention of null models in this analysis and therefore we do not know whether any of the models in the analysis have more support than a null model. In other words, we do not know whether any meaningful inferences can be made from this analysis. See my comments in the results section on the ability to draw inferences from the results presented here.

(2) Given that only a single covariate for vegetation structure and composition was included (% evergreen cover) in the occupancy models, it would be highly unlikely that this analysis could arrive at any other conclusion other than % evergreen cover is related to lynx occupancy. We know that lynx are associated with forests and since no other covariates for lynx habitat were included, the answer was this case, backed into the cake from the beginning.

M. Fernandes

We included three covariates on detection probability: snow conditions (good, fair, or poor), transect length (km), and date, which were recorded during each survey.

Data analysis – Additional information required

(1) Provide biological justification for choice of covariates.

(2) The USGS' GAP Analysis Program website provides additional covariates that should be included in this analysis. Even if this is an analysis of a single season of data collection, I think the data may support more insightful models.

M. Fernandes

We investigated both a linear and quadratic effect of date to allow for possible nonlinear changes in detectability. Route length was log-transformed and all other continuous covariates were standardized by subtracting the mean and dividing by the standard deviation.

Data analysis – Choice of models
"We investigated both a linear and quadratic effect of date to allow for possible nonlinear changes in detectability"

(1) Including additional response functions is a good idea but without biological justification, a quadratic detection response appears to be a peculiar choice. A quadratic function models lynx detection as increases over time until reaching a maximum rate and thereafter it decreases with each additional survey occasion. What is the biological scenario being modeled here?

(2) It seems to me that a threshold function would be a more appropriate model for detection prob., especially because it would allow us to determine what point additional sampling is not going to increase lynx detection.

(3) Why were nonlinear models for occupancy rate not included? It would be good to include additional nonlinear models.

M. Fernandes

We fit all possible model combinations, resulting in a total 256 models.

Data analysis

(1) A dredging approach to data analysis is generally not appropriate. Given that this is a pilot study intended to answer specific questions (not identified in this report), an exhaustive approach is particularly not well suited. Even if computing power allows for such an approach, some or many of the models would likely be biologically nonsensical.

(2) Again, because the goal of a pilot study is to inform how a study should proceed, a hypothesis testing approach is a far more productive approach. See my comments on how to redo the analysis.

M. Fernandes

We compared models using Akaike's Information Criterion corrected for small sample size (AICc), the difference in AICc units from the most parsimonious model (ΔAICc) and relative model support(AICc weights; Burnham and Anderson 2002). We considered models with ΔAICc <2 as fitting similarly well (Burnham and Anderson 2002). We used model-averaged parameter estimates to evaluate covariate effects on lynx occupancy and detection (Burnham and Anderson 2002). Model-averaged parameter estimates were then used to predict lynx occupancy across the entire study area.

Data analysis – Additional information required
Provide a few more sentences to help your audience understand model selection, AIC, and model averaging.

M. Fernandes

All analyses were conducted in R statistical software version 3.2.2 (R Development Team 2015) using the packages unmarked and MuMin.

Data analysis – Additional information required
Provide citations for both software packages and explain how they were used. I presume that MuMIn was used to generate all possible combinations of the models, correct?
M. Fernandes

Occupancy models require a closure assumption where each cell is permanently occupied or not occupied during the study period. Due to the nature of this study, we adopted a different interpretation where occupancy (ψ) was interpreted as the probability of lynx site usage during the study period (MacKenzie et al. 2006). This interpretation allows for more flexibility in relaxing the closure assumption, which was likely violated during the surveys.

RESULTS

My comments on the results sections are bellow table 1. M. Fernandes

Over the course of the study, there were >3,100 km of snow-tracking surveys across 231 of the 899 grid cells (Figures 1 and 2). The distribution of the number of surveys per cell was (100, 45, 20, 11, 16, 7, 11, 6, 5, 1, 3, 1, 0, 2, 1) i.e., 100 cells were surveyed once, 45 cells surveyed 2 times… 1 cell surveyed 15 times (Figure 2). Lynx were detected in 64 grid cells (Figure 1).

Comment [UFS1]: Provide a histogram

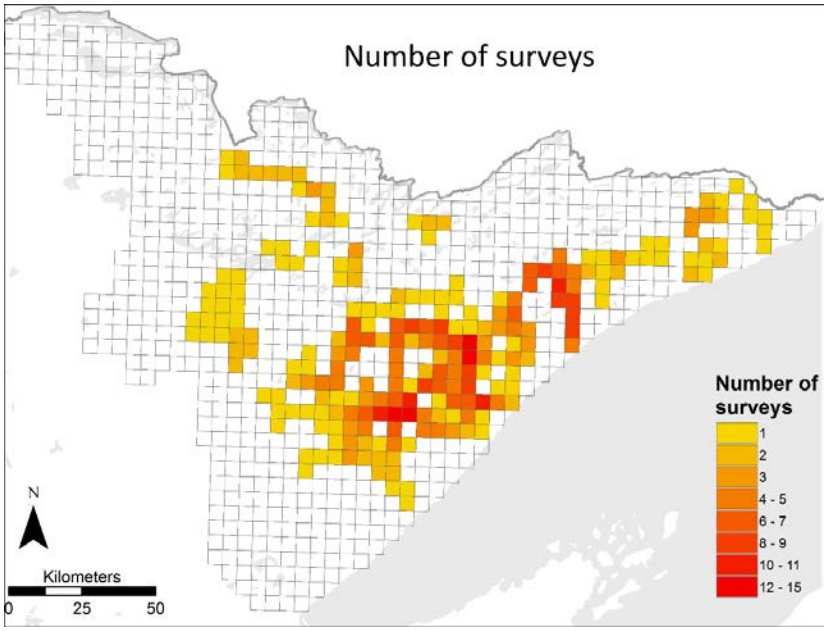


Figure 2. Number of snow-tracking surveys conducted per grid cell during winter 2014-2015.

Percent evergreen forest and percent water were included in the top model for occupancy (Table 1). Lynx occupancy increased as percent evergreen and percent water increased, although the confidence interval for percent water overlapped zero (Table 2). Transect length, snow conditions, and date of survey were included in the top model as covariates on detection (Table 1). Lynx detection probability was highest in good snow conditions and increased as transect length increased (Table 2; Figure 3).

Predicted lynx occupancy across the study area was generally highest in the northeast section of Superior National Forest and lowest in the southwest (Figure 4). Predicted lynx occupancy was >0.50 in 435 of the 899 cells (i.e., predictions suggested 48% of the cells were more likely than not that used by lynx).

Predicted lynx occupancy could also be investigated at the level of Lynx Analysis Units. For instance, Lynx Analysis Unit SNF47 overlapped 15 grid cells (western section of Superior National Forest). The mean occupancy for grid cells overlapping SNF47 was 0.17 and predicted occupancy was <0.50 in all overlapping cells (range = 0.02-0.42; Figure 5). Conversely, Lynx Analysis Unit SNF43 (northeast) overlapped 9 cells, with a mean predicted occupancy of 0.93 and predicted occupancy >0.80 in all cells (range = 0.84- 0.96; Figure 5).

Table 1. Model selection results for models of lynx occupancy and detection. Only models <2 ΔAICc units of the top model are shown. Shown are the occupancy and detection models, degrees of freedom (df), Akaike's information criterion corrected for small sample size (AICc), the distance in AICc units from the most parsimonious model (ΔAICc) and AIC weights (w_i).

Model					
Occupancy	**Detection**	**df**	**AICc**	**ΔAICc**	**w_i**
ψ(everg + H_2O)	p(len + snow + date)	8	608.9	0.00	0.11
ψ(everg + H_2O)	p(len + snow)	7	609.1	0.11	0.10
ψ(everg)	p(len + snow + date)	7	609.7	0.73	0.08
ψ(everg)	p(len + snow)	6	610.0	1.02	0.07
ψ(everg + H_2O + develop)	p(len + snow + date)	9	610.5	1.52	0.05
ψ(everg + H_2O + develop)	p(len + snow)	8	610.6	1.66	0.05

Comment [UFS2]: The full complement of models should be available as an appendix.

Data analysis & results interpretation

The results of this analysis are inconclusive for the reason summarized below.

- As stated earlier, the apparent absence of null models (*i.e.*, $\psi(.)$ and $p(.)$) makes it difficult to determine the ability to draw inferences from this analysis.
- The analysis included a single lynx habitat vegetation covariate and therefore it is likely that the model selection reported here is an artifact of the choice of models included in the analysis.
- Table 1 shows models that are within 2 ΔAIC, these models have in total < 50% of the support in the data (w_i column in the red box). Given that after the second best fit model, all other models have less than < 10 % support each, I presume that with the exception of the first two models, all other models have similar support. In other words, of the models that adequately model lynx occurrence and detection (*i.e.,* those within 2 ΔAIC), the two best models have only 22% support in the data and the remaining 4 models with 2 ΔAIC have similar support as 250 other models – this is what I would call inconclusive.
- Of the coefficients shown in Table 2 only one occupancy parameter (% evergreen) confidence interval does not include zero. Of the 6 detection rate covariates (snow: Good not shown – why?) only two have confidence intervals that do not include zero. This means that most of the covariates in the best fit models may in fact have not effect on either lynx occurrence or detection. Again, these are inconclusive results.

M. Fernandes

Table 2. Logit-scale model-averaged parameter estimates (95% confidence interval) from snow-tracking surveys of lynx conducted in Superior National Forest and designated critical habitat in northern Minnesota.

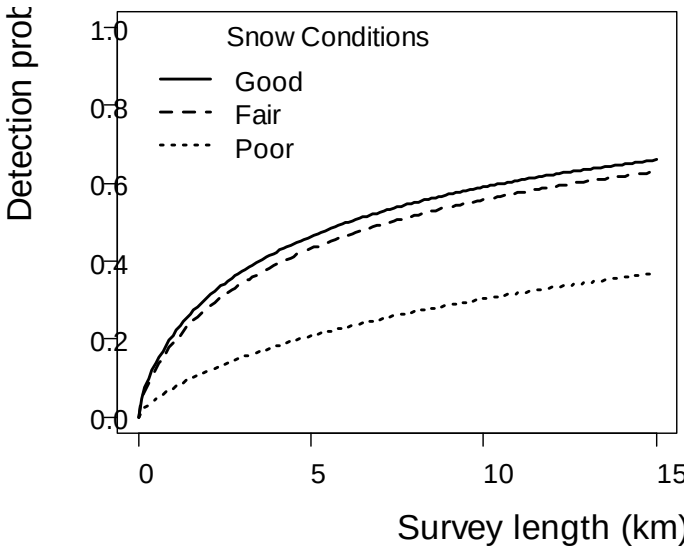
Parameter	Mean	2.5%	97.5%
OCCUPANCY			
Int.	0.26	-0.39	0.91
everg	1.74	0.93	2.56
H_2O	0.22	-0.08	0.82
develop	-0.15	-1.44	0.59
road	0.07	-0.78	1.25
DETECTION			
Int.	-1.32	-2.14	-0.51
length	0.73	0.36	1.11
snow:fair	-0.13	-0.73	0.46
snow:poor	-1.20	-1.83	-0.57
date	0.09	-0.05	0.38
$date^2$	0.01	-0.19	0.25

Results - Addition information required
Real parameter estimates and their CI's should also be provided.

M. Fernandes

What happened to snow: Good?

M. Fernandes



Results - Addition information required
The function used to produce this figure should be provided.

M. Fernandes

Data analysis – Model structure
The projected relationship between detection probability and survey length shown in this this figure supports my suggestion that a threshold detection model should have been included in the analysis.

M. Fernandes

Figure 3. Effect of survey length and snow condition on lynx detectability during snow-tracking surveys.

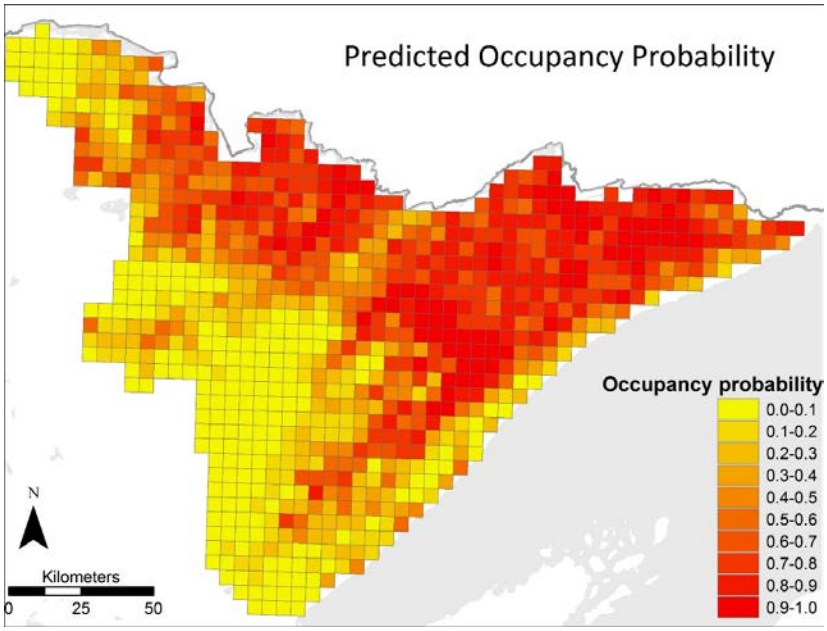


Figure 4. Predicted lynx occupancy probability across Superior National Forest and designated critical habitat in northern Minnesota.

Results - Addition information required
The occupancy function used should be provided and how predicted occupancy was mapped should be explained.

M. Fernandes

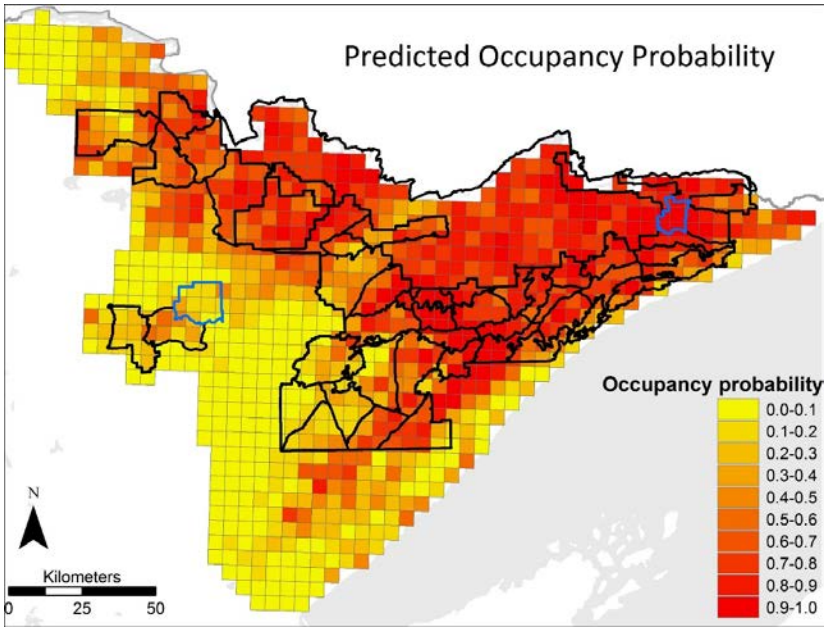


Figure 5. Predicted lynx occupancy probability across Superior National Forest and designated critical habitat in northern Minnesota. Polygons denote Lynx Analysis Units (LAUs; *n* = 47). Blue polygons are the two LAUs discussed in the Results. SNF43 (northeast) overlaps nine 5x5km grids with a mean occupancy probability of 0.93. SNF47 (west) overlaps 15 grid cells with a mean occupancy probability of 0.17 (see Results for details).

Results - Addition information required

The occupancy function used should be provided and how predicted occupancy was mapped should be explained.

M. Fernandes

DISCUSSION

A key requirement to estimate species occupancy, density, or abundance is not only detection data, but information on survey effort (i.e., when and where surveys were conducted; Royle and Young 2008). Our focus in 2014 was directed towards study design considerations, with an emphasis on recording both lynx detections and survey effort. The pilot study conducted in 2014-2015 provided important information on Lynx monitoring across Superior National Forest. For instance, the probability of detecting lynx was found to be <<1.0 and a function of both snow conditions and survey length. Similarly, lynx occupancy was associated with habitat characteristics resulting in noticeable variation in lynx occupancy across Superior National Forest and areas of critical habitat.

Habitat relationships suggested lynx occupancy was highest in the northeastern section of Superior National Forest and generally lowest at the southern and western regions of the forest. Lynx occupancy was primarily associated with percent of evergreen forest, an important habitat for their primary prey - snowshoe hares (Squires and Ruggiero 2007). Habitat covariates investigated by this study were a crude representation of possible lynx habitat relationships. Our results, however, support previous predictions of core lynx habitat in Superior National Forest (Moen et al. 2008; McCann and Moen 2011), which used a combination of intensive radio-telemetry of individually marked lynx and snowshoe hare pellet counts. Overall, detection/non-detection surveys appear to provide useful information on lynx distribution and habitat use, while also supporting results from previous studies in the region. Future exploration into more recent and/or detailed habitat data may provide additional insight into these relationships and predictions across the region.

Increased spatial coverage of surveys will be useful to better understand lynx habitat use and distribution throughout the region. For instance, regions of low lynx occupancy were often the least surveyed areas of the forest (Supplement S1). Additional surveys of low occurrence areas may help identify non-detection versus true absence of lynx these areas. Similarly, expanding surveys of high occupancy areas will assist in verifying high lynx use in these areas.

In considering survey design for abundance estimation, we note that genetic data collection in winter 2014-2015 resulted in 36 individually identified lynx. Only 8 of these individuals were detected at multiple locations, resulting in an inability to provide precise estimates of movement and density. Mark-recapture studies to estimate lynx density will likely require additional resources specifically dedicated to mark-recapture surveys. As with occupancy surveys, mark-recapture studies will benefit from both increased spatial coverage, but also increases in the number of surveys to collect genetic material.

Estimates of occupancy from this pilot study provide useful information on the distribution of a difficult to monitor threatened species and can be used to inform future study designs to monitor occupancy or more intensive abundance studies. Snow-tracking surveys that record detection/non-detection data provide a cost-effective survey approach for lynx (Squires et al. 2004). Snow tracking surveys can often survey extensive areas without the need for individual identification (Squires et al. 2004). In this pilot study, recording effort and detection/non-detection data allowed estimation of occupancy, detection, and habitat relationships. These approaches allowed for predictions across the entire study area, both surveyed and unsurvey areas. Continuing to record survey effort and detection/non-detection data will also allow investigation of dynamic processes in lynx occurrence across multiple years. Annual variation in lynx occupancy may be particularly important as Superior National Forest is at the southern edge of the lynx range and also known to have dramatic population fluctuations (Hornseth et al. 2014).

LITERATURE CITED

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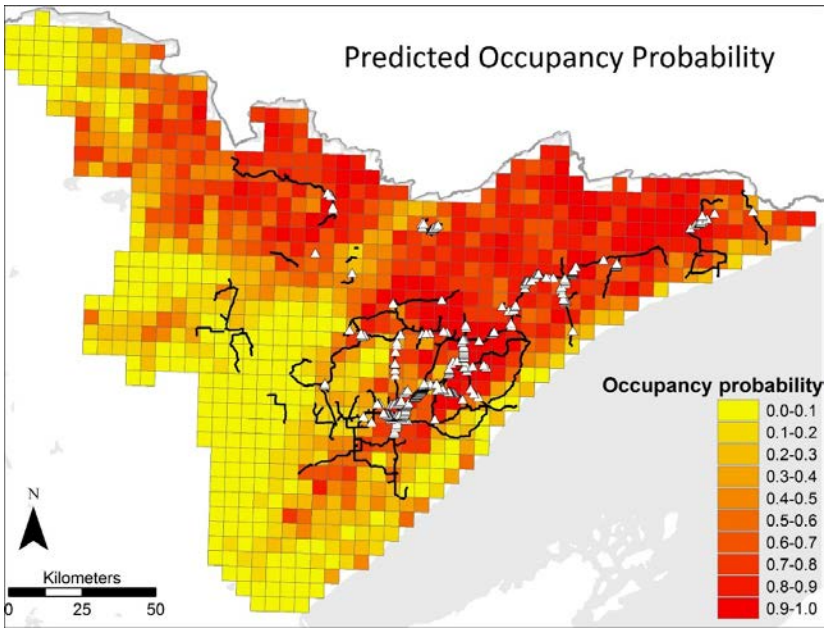
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SUPPLEMENT S1. Predicted lynx occupancy probability across Superior National Forest and designated critical habitat in northern Minnesota. Survey routes are overlaid in black and lynx detections are shown as white triangles.



From:	Zelenak, Jim
To:	Jodi Bush
Cc:	Katrina Dixon; Thomas Olenicki; Ben Conard
Subject:	Fwd: FW: 2670 : Northern Rockies Lynx Management Decision
Date:	Monday, May 09, 2016 7:50:50 AM
Attachments:	ScannedSignedLetter.pdf

In case you haven't seen it already, this is the letter from R1 USFS Regional Forester Leanne Marten responding to Mike Garrity's (Executive Director, Alliance for the Wild Rockies) earlier letter asking that the USFS amend forest plans and/or the NRLMD, specifically guidance on veg. standards/thresholds, to incorporate the new best available science represented by Megan Kosterman's Master's thesis work on habitat factors influencing some aspects of lynx reproductive success, including amount and contiguity of mature forest stands.

That was the topic of discussion at the Jan. 21 meeting Katrina and I attended in Missoula.

---------- Forwarded message ----------
From: **Hanvey, Gary -FS** <ghanvey@fs.fed.us>
Date: Fri, May 6, 2016 at 4:42 PM
Subject: FW: 2670 : Northern Rockies Lynx Management Decision
To: "Zelenak, Jim" <jim_zelenak@fws.gov>

fyi

From: Hanvey, Gary -FS
Sent: Wednesday, April 20, 2016 12:56 PM
To: Krueger, Joseph -FS <jkrueger@fs.fed.us>
Subject: FW: 2670 : Northern Rockies Lynx Management Decision

Just got this ……

From: Burks, Leonard -FS **On Behalf Of** FS-Mailroom R1
Sent: Wednesday, April 20, 2016 12:55 PM
To: FS-Mailroom R1 <mailroom_r1@fs.fed.us>
Cc: Johnston, Eric -FS <ejohnston@fs.fed.us>; Dawe, Christine -FS <cdawe@fs.fed.us>; Hanvey, Gary -FS <ghanvey@fs.fed.us>; Persico, Tristan - FS <tpersico@fs.fed.us>; Burks, Leonard -FS <leonardburks@fs.fed.us>
Subject: 2670 : Northern Rockies Lynx Management Decision

Link to Work Package FY 2016 - 106831: https://ems-portal.usda.gov/sites/fs-wo-csa1/Mercury/_layouts/15/DocIdRedir.aspx?ID=CV22QSYQPP7S-2-281676

Mailed in US Mail to: Michael Garrity, Executive Director, Alliance for the Wild Rockies, P.O. Box 505, Helena, MT 59624

Sara Jane Johnson, PhD Director, Native Ecosystems Council
P.O. Box 125 Willow Creek, MT 59760

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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

USDA United States Department of Agriculture Forest Service Region One

Northern Region
26 Fort Missoula Road
Missoula, MT 59804

File Code: 2670
Date: APR 20 2016

Michael Garrity
Executive Director
Alliance for the Wild Rockies
P.O. Box 505
Helena, MT 59624

Dear Mr. Garrity,

Thank you for your March 18, 2016 email correspondence regarding the Northern Rockies Lynx Management Decision (NRLMD) and the 2014 thesis produced by Megan Kosterman. My staff in the Regional Office have been fully aware of the thesis for some time. They have been working with Ms. Kosterman herself, the US Fish and Wildlife Service and scientists from the Forest Service Rocky Mountain Research Station (RMRS) to understand the relationship between the 2014 thesis and the NRLMD.

While the 2014 thesis provides valuable new information with potential to inform changes in Forest Service management of lynx and lynx habitat, the relationships between vegetation composition and lynx reproduction success in NW Montana described in the thesis are not well enough understood to determine if, or what, specific changes in management direction are warranted. Therefore, it is premature to conclude that the current management direction provided in the NRLMD is inadequate, as you suggest. By design, the 2014 thesis classified vegetation in a way that was deliberatively imprecise in order to allow the researcher to correlate lynx demography to habitat in a simple and rough sense. And to this end, the work was a success. We are finding however, that the parameters and metrics used to demonstrate this relationship do not cross-walk well to the metric standards provided in the NRLMD. Two examples are summarized below.

VEG S1. The 30% threshold value of an LAU in early stand initiation structural stage prescribed in NRLMD standard VEG S1, is not directly comparable to the 10-15% optimum level of young regenerating forest identified in the 2014 thesis. The 2014 thesis grouped vegetation into five categories, one of which was young regenerating forest. The calculation for the NRLMD VEG S1 standard threshold of 30% could include vegetation in at least three of the five vegetation categories described in the thesis, including: 1) open – trees not present; 2) thin forest; and, 3) young regenerating forest. Thus, the optimum 10-15% amount of young regenerating forest identified in the 2014 thesis appears to be a subset of the vegetation types used to calculate the 30% threshold standard in the NRLMD.

VEG S6. The greater than 50% mature forest optimum vegetation class described in the thesis is broadly defined as large trees with continuous canopy and no evidence of recent disturbance. This class could include a wide range of stand conditions, including mature stands of single-storied trees with little to no understory (stem exclusion structural stage), and mature stands of

multi-storied trees with dense understories. The latter category provides the quality snowshoe hare habitat addressed by Standard VEG S6 in the NRLMD. The mature vegetation class in the thesis does not distinguish between single versus multi-storied mature forest structures and does not address understory horizontal cover metrics within lynx home ranges included in the study. Thus, the optimum 50% amount of mature forest identified in the 2014 thesis appears to include a large range of mature forest structural types that may or may not provide quality habitat for snowshoe hare. Until we better understand the actual structural makeup of those mature forest stands within the lynx home ranges, it is not currently possible to identify more desirable mature forest conditions within LAUS than what is currently provided in the NRLMD.

Ms. Kosterman and RMRS scientists are working to publish her work in a peer reviewed scientific journal and it should also be noted that some of the findings in the original thesis may change through that process. Please also note that we fully recognize the importance of this study and its implication for improved management direction. My staff will continue to work in partnership with the US Fish and Wildlife Service, the RMRS and Ms. Kosterman to interpret her work as it relates to management of Canada lynx and the NRLMD.

Sincerely,

LEANNE M MARTEN
Regional Forester

cc: Eric Johnston; Christine Dawe; Gary Hanvey; Sara Jane Johnson, PhD Director, Native Ecosystems Council P.O. Box 125 Willow Creek, MT 59760

From: Hanvey, Gary -FS
To: Zelenak, Jim
Cc: Dixon, Bev -FS; Kuennen, Reed -FS
Subject: RE: FW: incidental lynx trapping
Date: Tuesday, October 11, 2016 4:08:37 PM

Thanks Jim. I'm assuming that LPZ's are identified in the trapping regs. I'll go to their web site and look…….

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, October 11, 2016 3:53 PM
To: Hanvey, Gary -FS <ghanvey@fs.fed.us>
Cc: Jackson, Scott -FS <sjackson03@fs.fed.us>; Dixon, Bev -FS <bdixon@fs.fed.us>; Jodi_Bush@fws.gov
Subject: Re: FW: incidental lynx trapping

Also attached here is a summary provided by MTFWP of trapping regulation changes 1999-2015 to protect lynx and reduce likelihood of incidental trapping. I thought this might be useful for Bev in addressing potential for incidental trapping of lynx on the Custer-Gallatin - most of which I think is in one of the State's new Lynx Protection Zones (LPZs).

On Tue, Oct 11, 2016 at 3:09 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Gary et al.,
>
> See replies in red below.
>
> Let me know if there's anything else we can provide.
>
> Jim
>
> On Tue, Oct 11, 2016 at 9:42 AM, Hanvey, Gary -FS <ghanvey@fs.fed.us> wrote:
>
> > Hey Jim. Some questions.
> >
> > Did you collect any info relative to trapping/shooting during your status review?

Yes. The most current info on
REPORTED
incidental
capture from trapping
in MT (attached) comes from a
summary
FWP submitted to us recently. Other Service lynx biologists from other parts of the DPS also collected and summarized the available information on incidental trapping and illegal shooting. That info will be in the draft SSA report that we hope you will see soon. If you need incidental take info from other states before then, let me know and I will try to pull them from the draft SSA
or query the lynx biologists from our other regions/field offices

.

> Since lynx are federally protected, isn't the Service notified of all mortalities?

Yes, at least in theory. We had been previously made aware of most, but not all, of the incidental take in the attached FWP data. Most reporting was to our "Division of Management Authority" (DMA) in D.C., which oversees the CITES Program. MT, like most lynx range states, participates in the CITES bobcat trapping/exporting program, which requires them to report all incidental take of lynx. In the past, Brian Giddings (formerly FWP furbearer manager in Helena) would sometimes send reports to DMA but not to FWS here in Helena, but we eventually received most of them from DMA. I asked Brian, and now his successor, Bob Inman, to copy us on any incidental take reports they file with DMA as per CITES program requirements. Keep in mind that it is possible, if not likely, that incidental take occurs that is not reported - that is, there are likely lynx mortalities about which we are not notified because they are not reported to FWP, other states, or DMA.

> And, wouldn't the Service keep records of those?

Yes, although that record-keeping appears to have been spotty in the past, and I don't think it is currently centralized or assigned to anyone in particular. A couple years back, before we received the attached info from FWP, I pulled together all the info on incidental trapping/shooting in MT that I could based on the Original CITES BA/BO from 2001 and the reports that we'd received here from FWP or DMA - some sent to Lori Nordstrom and others later to Shawn Sartorius. I've attached that also (my Feb. 2013 update based on info I could find here). Most of the records there match records in the FWP summary, though there is some disparity in dates and other details.

> And, does anyone in the Service track lynx mortalities?

As described above. Other FWS field offices also track incidental trapping, illegal shooting, and vehicle collisions in their areas (e.g., Maine, Minnesota, etc.). Kurt Broderdorp in our Western Colorado Field Office has been unofficial keeper of lynx-vehicle collision data, and he provided the attached update (excel spreadsheet) in Feb. 2016 after we queried partners in each state for any new info on collisions.

From: Hanvey, Gary -FS
Sent: Tuesday, October 11, 2016 9:36 AM
To: Jackson, Scott -FS <sjackson03@fs.fed.us>; Dixon, Bev -FS <bdixon@fs.fed.us>
Cc: Squires, John -FS <jsquires@fs.fed.us>
Subject: RE: incidental lynx trapping

Bev. I'm trying to track this info as well for the Flathead Revision BA. As you know the state was litigated over trapping issues not long ago, and was requesting info from Squires in response to the suit. So, I have asked John for some help on this issue as well. We'll let you know what we find out.

From: Jackson, Scott -FS
Sent: Tuesday, October 11, 2016 9:23 AM
To: Dixon, Bev -FS <bdixon@fs.fed.us>; Hanvey, Gary -FS <ghanvey@fs.fed.us>
Subject: RE: incidental lynx trapping

Hi Bev,

I don't know specifics. Brian Giddings retired and Bob Inman is the new FWP furbearer/carnivore biologist. I'll see him this afternoon and ask him. I'll let you know if I find out anything of interest. Thanks.

Scott Jackson
National Carnivore Program Leader

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sjackson03@fs.fed.us

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From: Dixon, Bev -FS
Sent: Tuesday, October 11, 2016 8:58 AM
To: Hanvey, Gary -FS <ghanvey@fs.fed.us>; Jackson, Scott -FS <sjackson03@fs.fed.us>
Subject: incidental lynx trapping

Howdy – I'm working on the plan revision assessment for the Custer Gallatin, and felt the need to address potential for incidental trapping of lynx. The (2013) LCAS says: "in Montana, 10 lynx were reported trapped (bet 2000-2012), of which at least 4 died." (p. 79). Do either of you know whether any lynx have been incidentally trapped (or shot) on or near the CGNF? I couldn't find specific info on FWP website. I can contact Brian Giddings, but thought one of you might know the answer. Thanks.

Bev Dixon
Wildlife Biologist, Forest Plan Revision Team

Forest Service
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(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Hanvey, Gary -FS
Subject: Re: FW: incidental lynx trapping
Date: Wednesday, October 12, 2016 10:47:06 AM

Yes - the final SSA will be made publicly available. Not sure about the draft.

I don't recall coming across any incidental trapping info for Wyoming. I think you provided us with info on recent incidental captures in ID. Not sure how much detail will be in the SSA regarding those. I will forward your question to Lisa Solberg-Schwab, our lynx biologist in Cheyenne, and Bryon Holt for northern Idaho and ask them to get back to you.

On Tue, Oct 11, 2016 at 3:56 PM, Hanvey, Gary -FS <ghanvey@fs.fed.us> wrote:

> Thanks Jim! This info is what I had hoped you could provide. Because some would regard this info to be "sensitive" in nature, I will not share it w/ FS Bios unless they need and request it for NEPA purposes (as Bev and Reed have requested for Forest Plan Revision planning). Will the Draft SSA and/or Final SSA be made available to the public?
>
> I would like to also have any info from WY and ID since both states have Forests w/in the Northern Planning Area (NRLMD). Would the same info you provided for MT also be in the Draft SSA for WY and ID? If so, and if the Draft SSA will be coming soon, I can wait for the report to come out. But, if the Draft will not be coming out for awhile, OR if the records in the SAA are lumped and/or summarized by state (as opposed to being itemized as in these MT data), let me know – we can discuss how much trouble/work it would be for you to dig those up.
>
> But, thanks much for these MT data……
>
> **From:** Zelenak, Jim [mailto:jim_zelenak@fws.gov]
> **Sent:** Tuesday, October 11, 2016 3:09 PM
> **To:** Hanvey, Gary -FS <ghanvey@fs.fed.us>
> **Cc:** Jackson, Scott -FS <sjackson03@fs.fed.us>; Dixon, Bev -FS <bdixon@fs.fed.us>; Jodi_Bush@fws.gov
> **Subject:** Re: FW: incidental lynx trapping
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> Hi Gary et al.,
>
> See replies in red below.

Let me know if there's anything else we can provide.

Jim

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> Hey Jim. Some questions.
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> Did you collect any info relative to trapping/shooting during your status review?

Yes. The most current info on

REPORTED

incidental

capture from trapping

in MT (attached) comes from a

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FWP submitted to us recently. Other Service lynx biologists from other parts of the DPS also collected and summarized the available information on incidental trapping and illegal shooting. That info will be in the draft SSA report that we hope you will see soon. If you need incidental take info from other states before then, let me know and I will try to pull them from the draft SSA

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> **Cc:** Squires, John -FS <jsquires@fs.fed.us>
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Scott Jackson
National Carnivore Program Leader
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From: Dixon, Bev -FS
Sent: Tuesday, October 11, 2016 8:58 AM
To: Hanvey, Gary -FS <ghanvey@fs.fed.us>; Jackson, Scott -FS <sjackson03@fs.fed.us>
Subject: incidental lynx trapping

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Bev Dixon
Wildlife Biologist, Forest Plan Revision Team
Forest Service

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Jim Zelenak, Biologist

U.S. Fish and Wildlife Service

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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Steve Gess
Subject: Draft SOW for Lynx Peer Review
Date: Wednesday, July 13, 2016 2:54:42 PM
Attachments: Final SOW Lynx SSA July 15 2016.doc

Hi Steve. As we discussed here is the draft SOW for the Peer Review. Kaimy (my AO) has the PR ready and will submit once we hear from you that the SOW looks good. Thanks for your help. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

Order Statement of Work
Peer Review (without attribution) of the Scientific Findings in
U.S. Fish and Wildlife Service's Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis).

Date: July 15, 2016

1. Introduction/Background

The U.S. Fish and Wildlife Service (Service) has conducted a species status assessment (SSA) as a first step to understand the current status of the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis), currently listed as threatened under the Endangered Species Act (Act). The SSA is intended to inform and streamline the court-ordered recovery plan (due January15, 2018), assuming such a plan is deemed necessary. The SSA report will also serve as the basis for the five-year status review (initiated in 2007; 72 FR 19549) required under the Act and would also provide the scientific foundation to support future rulemaking in accordance with the Act should the five-year review indicate that a change in the DPS's listing status is warranted.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the Act in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx and lynx habitats occurred on national forests, and that the Land and Resource Management Plans that guided management of those forests included "...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species" (65 FR 16052).

Currently, there are five geographic areas known to support resident lynx populations in the DPS: northern Maine (with occasional/sporadic breeding by small numbers of lynx in northernmost New Hampshire and Vermont); northeastern Minnesota; northwestern Montana and northeastern Idaho; north-central Washington; and western Colorado. After statewide surveys conducted in 1978-1997 suggested the absence of viable resident lynx populations in Colorado, the State, from 1999 to 2006, released 218 lynx captured in Canada and Alaska into southwest Colorado to establish the current resident population. Additionally, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming is believed historically (and as recently as 2003-04) to have supported a small but relatively persistent lynx population, but it is uncertain whether it currently supports any resident lynx.

In accordance with the Service peer review policy, we are requesting peer review of this species status assessment (SSA).

2. Description of Review

We are seeking peer review of this species status assessment (SSA). The purpose of the review is to help us ensure that we have used the best scientific and commercial information when we make our final decision as to the current status of the lynx. Thus, we are looking for independent scientific perspectives on the comprehensiveness and logic of the document, as well as how well

the technical conclusions are supported by the data and analyses. Peer reviewers should be advised that they are not to provide advice on policy.

3. Methods, Protocols and/or Scientific Standards

The selection of participants in a peer review is based on expertise, with due consideration of independence and conflict of interest (OMB –IQ bulletin for Peer Review). The most important factor in selecting reviewers is expertise: ensuring that the selected reviewer has the knowledge, experience, and skills necessary to perform the review. The independent peer reviewers shall be experienced senior-level ecologists, carnivore biologists, population modelers, and/or furbearer managers who have previously conducted similar reviews or regularly provided reviews of research and conservation articles for the scientific literature. Reviewers must be well-versed in the demographic management of mammals, preferably lynx or other carnivores. While expertise is the primary consideration, reviewers should also be selected to represent a diversity of scientific perspectives relevant to the subject.

Potential conflicts of interest include: employment or affiliation with the Service, the States, the Interagency Lynx Conservation Team, the Western Governors Association; peer reviewers who have offered a public opinion or a statement either for or against delisting; and peer reviewers directly or indirectly employed by or associated in any way with any organization that has either litigated the federal government concerning lynx or taken a position on one side or the other about recovery and listing of lynx. The contractor will be responsible for assigning an experienced, senior and well-qualified manager to lead this review and for the selection of 3-5 well-qualified, objective, independent reviewers (a minimum of 3 individuals must provide review; more is preferred). The expertise of qualified reviewers shall include at least 2 reviewers who meet criteria 1 and 2 and 4 below, and at least one reviewer who meets criteria 1 and 3 and 4: and representative of the DPS range of lynx including northeastern US, the Midwest, the Rocky Mtns and Canada.

1. A Ph.D. or an M.S. (with significant experience) in Wildlife Biology/Ecology, Ecology, or Wildlife Management or other related fields as long as they meet the other qualifications below.
2. Demonstrated experience working with the management of carnivores, especially lynx or other furbearers, and wildlife population management.
3. Expert knowledge of wildlife biology, wildlife management, demographic management of mammals (especially carnivores), wildlife population dynamics, and/or wildlife population modeling, as well as being generally versed in available literature on lynx and other carnivores, boreal forest systems, and changes in climate within boreal forest systems.
4. Expert knowledge of boreal forest ecosystems and effects of climate change within those ecosystems within Canada and the US is preferred.
5. Experience as a peer reviewer for scientific publications.

In addition, the reviewers must have no financial or other conflicts of interest with the outcome or implications of the report (reviewers should not be currently employed by the Service, State agencies within the lynx DPS range, or employed by (or contracted by) any organization that has either litigated or taken a position on lynx listing or recovery.

The Service will have an opportunity to seek clarification on any review comments through the contractor (Task 003.1), for a period of 10 days, starting 60 days after the Service receives the reviews from the contractor.

Peer Reviewers will provide individual, written responses. Peer Reviewers should be advised that their reviews, including their names and affiliations, will (1) be included in our administrative record, and (2) will be made available to the public. We will summarize and respond to the issues raised by the peer reviewers in the record.

Collectively, the review should cover, but not be limited to, the topics listed below. Individual reviewers should, at their own discretion, provide comments, criticisms, and ideas about any of the topics they feel qualified to comment on. The most valuable reviews will focus on how thoroughly and logically the topics have been treated, and how well the conclusions are supported by the data and analyses. Not all reviewers are required to address all issues noted below. Reviewers should comment on areas within their expertise, and may choose to abstain from other areas including restricting your technical comments to your area of expertise, but feel free to render opinions or raise questions about larger scientific issues that may be relevant. To the extent possible, justify your comments with supporting evidence just as you would do when presenting your own scientific work. Please do not refrain from offering relevant opinions, but also label them as such. Test your comments for fairness, objectivity and tone of delivery by asking yourself if you would be comfortable presenting your comments, face-to-face, to the author and a panel of your peers.

Questions for Peer Review

Available Data

1. Please identify any oversights or omissions of data or information, and their relevance to the assessment. Are there others sources of information or studies that were not included that are relevant to assessing the viability of this species? What are they are how are they relevant?

2. Provide advice on the overall strengths and limitations of the scientific data used in the document. Have the authors been explicit about assumptions and limitations of, and concerns regarding, the data, and are these appropriately qualified or explained? Are there concerns that the Service did not identify, and if so, how relevant are these concerns to the assessment of viability of lynx in the contiguous U.S.? Are there any inconsistencies in how the data are presented or assessed?

Analysis of Available Data

3. Have the assumptions and methods used in the SSA report been clearly and logically stated in light of the best available information? If not, please identify the specific assumptions and methods that are unclear or illogical.

4. Are there demonstratable errors of fact or interpretation? Have the authors of the SSA report provided reasonable and scientifically sound interpretations and syntheses from the scientific information presented in the report? Are there instances in the SSA report where a different but equally reasonable and sound interpretation might be reached that differs from that provided by the Service? If any instances are found where this is the case, please provide the specifics regarding those particular concerns.

5. Provide feedback on the inclusion and portrayal of uncertainty in the SSA report. Have the scientific uncertainties present given the data and the analyses conducted been clearly identified and has the degree of uncertainty been appropriately characterized? If not, please identify any specifics concerns.

Text to be added to correspondence with Peer Reviewers:

The Species Status Assessment framework is a new tool the U.S. Fish and Wildlife Service is using to improve transparency while conducting listing determinations and other Act actions, and peer review of our analyses of the viability of species is part of that new process. As you will see, the attached draft SSA report is a rough draft; we are seeking your comments at this stage to ensure that we have time to incorporate any substantial comments as we finalize the report.

As you review the document, please note that this draft SSA report does not result in or predetermine a decision by the Service on whether the Canada lynx warrants protections of the s Act. This document is strictly a characterization of the viability species' viability in the contiguous United States.

As a reminder, all peer reviews and comments will be public documents, and portions may be incorporated verbatim into the Service's final decision Document, should there be one, with appropriate credit given to the author of the review. If you do not want your name to appear in a final decision document, as published in the Federal Register, please inform us of this as soon as possible.

In general we ask that your comments on the draft SSA report focus specifically on whether the best available information was used, the quality of the scientific information, and our interpretation and analyses of the data with regard to the species' viability in the contiguous United States. We request that you direct your review to the scientific issues and assumptions related to your expertise.

In accordance with the agreement terms and Performance Work Statement, the contractor(s) is (are) reminded of the requirements to protect information and that services shall consist of unbiased assessments through proper management and enforcement of scientific integrity standards, to avoid any conflict of interest.

4. Required Service (Work) Items - Task Line Item Numbers (TLIN): As described in the agreement's Performance Work Statement, paragraph 2B, the below TLINs are required in the performance of this requirement. The TLINs are different, but interrelated to the tasks listed in task/deliverable and payment schedule**:**
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TLIN 002: Organizing, structuring, leading, and managing the scientific reviews and task order products.
TLIN 003: Managing and producing a final product.
TLIN 004: Responding to any follow-up questions from the Service on original review comments (not to exceed 10 consecutive days)
TLIN 005: Maintaining an official record for peer reviews or task orders.

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The following deliverables are in addition to the agreement's Performance Work Statement paragraph 3, which states, "The Contractor shall provide the COR with three key deliverables: (1) Proposed Timeline, (2) Original individual scientific reviews and a transmittal letter to the Service (to Regional Director, Noreen Walsh), and (3) Complete Official Record."

There are no additional deliverables. However, the contractor will be required to respond to questions, inquiries, or other related requests after the contract expiration date, and final acceptance, as needed. These request(s) will be by the Contracting Officer Representative (in coordination with the Contracting Officer). Inquiries or requests are limited to the products provided, and work performed under this contract (order). Responses include, but not limited to: phone calls, written responses, and/or meetings.

Review comments by the Contracting Officer Representative will be provided to the Contractor via the Contracting Officer.

6. Task Schedule.
The period of performance shall not exceed the contract expiration date without a contract modification. In accordance with the terms of the contract, the contractor shall notify the Contracting Officer of any delays. Delays by the Government or Contractor must be rectified by accelerating the next deliverable on a one to one basis (i.e., if the delay was 2 days then the next deliverable must be submitted 2 days early). Deliverables that fall on a holiday or weekend must be delivered on the first work day after the weekend or holiday. The period of performance (contract expiration date) includes all possible holidays or weekend deliveries:

TASK/DELIVERABLE	**CALENDAR DAYSAFTER AWARD**
Task 1: Contracting Officer and COR will provide access to materials needed for the review	3
Task 2: The contractor(s) shall conduct a thorough, objective peer review of the Service's Species Status Assessment for the contiguous United States distinct	17 (14 days)

population segment (DPS) of the Canada lynx (Lynx Canadensis)	
Task 3: The contractor(s) will provide 3-5 expert peer reviews and a transmittal letter to the Service (to Regional Director, Noreen Walsh)	22 (5 days)
Task 4: The project manager facilitates specific follow-up questions/answers between the Service and the reviewers (task limited to a 10-day period, 60 days after delivering initial review comments to the Service).	32 (10 days)
Task 5: The contracted project manager will provide all applicable official records to the Service project manager	42 (10 days)

7. Official Administrative Record
The preparation of an official administrative record is required.

8. Information Sources
The key information sources and links for this review will include: (1) the Draft Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx Canadensis, (2) the Final Report of the Canada Lynx Expert Elicitation Workshop, (3) the revised (Aug. 2013) interagency Lynx Conservation Assessment and Strategy (LCAS).

9. Payment Schedule:

The payment schedule is as follows: 100 percent upon completion of Task 5 above.

10. Service Points of Contact:
Contracting Officer, Mr. Steve Gess (phone: 303-236-4334, or email: steve_gess@fws.gov).

Contracting Officer's Technical Expert: Jodi Bush (phone: 406-449-5225, ext.205 or email: Jodi_bush@fws.gov **Project Lead**: Jim Zelenak, **Mailing Address**: 585 Shepard Road, Suite 1, Helena, MT 59601 **Telephone**: 406-449-5225, ext. 220 **Email**: jim_zelenak@fws.gov

11. List of Enclosures/Attachments
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2. Final Report of the Canada Lynx Expert Elicitation Workshop
3. Revised (Aug. 2013) interagency Lynx Conservation Assessment and Strategy (LCAS).

12. Evaluation Criteria (This paragraph will be deleted upon award)
This requirement will be awarded based on best value. Best value will take into consideration price (to include the level of effort applied to each major task), approach (to include the labor categories, TLINs applied to each major task, and the reviewer's resumes (lynx or carnivore ecologist/researcher/manager/modeler having performed similar reviews) (reference paragraph 3).

Price must detail cost in accordance with the agreement. The approach must include a detailed/ proposed schedule (timeline), and the disciplines/skill mix of reviewers. The approach should be no more than 2 pages (8 1/2" x 11", 12 point font), excluding information on costs. All contractors must propose five reviewers. Be sure to include the discipline/skills of all reviewers (e.g., a resume or CV).

From: Steve Gess
To: Jodi Bush
Subject: RE: Draft SOW for Lynx Peer Review
Date: Thursday, July 14, 2016 7:27:08 AM
Attachments: Final SOW Lynx SSA July 15 2016.doc

Jodi, I added two tasks (6 & 7) in the table of Tasks that you may want to consider—they are highlighted in Yellow—If not then let me know. Other than that, everything looked good..

Steven C. Gess, CPPO
Contracting Officer
US Fish & Wildlife Service
Region 6 Lakewood CO.
303-236-4334
Steve_gess@fws.gov

From: Bush, Jodi [mailto:jodi_bush@fws.gov]
Sent: Wednesday, July 13, 2016 2:55 PM
To: Steve Gess
Subject: Draft SOW for Lynx Peer Review

Hi Steve. As we discussed here is the draft SOW for the Peer Review. Kaimy (my AO) has the PR ready and will submit once we hear from you that the SOW looks good. Thanks for your help. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

Order Statement of Work
Peer Review (without attribution) of the Scientific Findings in
U.S. Fish and Wildlife Service's Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis).

Date: July 15, 2016

1. Introduction/Background

The U.S. Fish and Wildlife Service (Service) has conducted a species status assessment (SSA) as a first step to understand the current status of the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis), currently listed as threatened under the Endangered Species Act (Act). The SSA is intended to inform and streamline the court-ordered recovery plan (due January15, 2018), assuming such a plan is deemed necessary. The SSA report will also serve as the basis for the five-year status review (initiated in 2007; 72 FR 19549) required under the Act and would also provide the scientific foundation to support future rulemaking in accordance with the Act should the five-year review indicate that a change in the DPS's listing status is warranted.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the Act in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx and lynx habitats occurred on national forests, and that the Land and Resource Management Plans that guided management of those forests included "...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species" (65 FR 16052).

Currently, there are five geographic areas known to support resident lynx populations in the DPS: northern Maine (with occasional/sporadic breeding by small numbers of lynx in northernmost New Hampshire and Vermont); northeastern Minnesota; northwestern Montana and northeastern Idaho; north-central Washington; and western Colorado. After statewide surveys conducted in 1978-1997 suggested the absence of viable resident lynx populations in Colorado, the State, from 1999 to 2006, released 218 lynx captured in Canada and Alaska into southwest Colorado to establish the current resident population. Additionally, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming is believed historically (and as recently as 2003-04) to have supported a small but relatively persistent lynx population, but it is uncertain whether it currently supports any resident lynx.

In accordance with the Service peer review policy, we are requesting peer review of this species status assessment (SSA).

2. Description of Review

We are seeking peer review of this species status assessment (SSA). The purpose of the review is to help us ensure that we have used the best scientific and commercial information when we make our final decision as to the current status of the lynx. Thus, we are looking for independent scientific perspectives on the comprehensiveness and logic of the document, as well as how well

the technical conclusions are supported by the data and analyses. Peer reviewers should be advised that they are not to provide advice on policy.

3. Methods, Protocols and/or Scientific Standards

The selection of participants in a peer review is based on expertise, with due consideration of independence and conflict of interest (OMB –IQ bulletin for Peer Review). The most important factor in selecting reviewers is expertise: ensuring that the selected reviewer has the knowledge, experience, and skills necessary to perform the review. The independent peer reviewers shall be experienced senior-level ecologists, carnivore biologists, population modelers, and/or furbearer managers who have previously conducted similar reviews or regularly provided reviews of research and conservation articles for the scientific literature. Reviewers must be well-versed in the demographic management of mammals, preferably lynx or other carnivores. While expertise is the primary consideration, reviewers should also be selected to represent a diversity of scientific perspectives relevant to the subject.

Potential conflicts of interest include: employment or affiliation with the Service, the States, the Interagency Lynx Conservation Team, the Western Governors Association; peer reviewers who have offered a public opinion or a statement either for or against delisting; and peer reviewers directly or indirectly employed by or associated in any way with any organization that has either litigated the federal government concerning lynx or taken a position on one side or the other about recovery and listing of lynx. The contractor will be responsible for assigning an experienced, senior and well-qualified manager to lead this review and for the selection of 3-5 well-qualified, objective, independent reviewers (a minimum of 3 individuals must provide review; more is preferred). The expertise of qualified reviewers shall include at least 2 reviewers who meet criteria 1 and 2 and 4 below, and at least one reviewer who meets criteria 1 and 3 and 4: and representative of the DPS range of lynx including northeastern US, the Midwest, the Rocky Mtns and Canada.

1. A Ph.D. or an M.S. (with significant experience) in Wildlife Biology/Ecology, Ecology, or Wildlife Management or other related fields as long as they meet the other qualifications below.
2. Demonstrated experience working with the management of carnivores, especially lynx or other furbearers, and wildlife population management.
3. Expert knowledge of wildlife biology, wildlife management, demographic management of mammals (especially carnivores), wildlife population dynamics, and/or wildlife population modeling, as well as being generally versed in available literature on lynx and other carnivores, boreal forest systems, and changes in climate within boreal forest systems.
4. Expert knowledge of boreal forest ecosystems and effects of climate change within those ecosystems within Canada and the US is preferred.
5. Experience as a peer reviewer for scientific publications.

In addition, the reviewers must have no financial or other conflicts of interest with the outcome or implications of the report (reviewers should not be currently employed by the Service, State agencies within the lynx DPS range, or employed by (or contracted by) any organization that has either litigated or taken a position on lynx listing or recovery.

The Service will have an opportunity to seek clarification on any review comments through the contractor (Task 003.1), for a period of 10 days, starting 60 days after the Service receives the reviews from the contractor.

Peer Reviewers will provide individual, written responses. Peer Reviewers should be advised that their reviews, including their names and affiliations, will (1) be included in our administrative record, and (2) will be made available to the public. We will summarize and respond to the issues raised by the peer reviewers in the record.

Collectively, the review should cover, but not be limited to, the topics listed below. Individual reviewers should, at their own discretion, provide comments, criticisms, and ideas about any of the topics they feel qualified to comment on. The most valuable reviews will focus on how thoroughly and logically the topics have been treated, and how well the conclusions are supported by the data and analyses. Not all reviewers are required to address all issues noted below. Reviewers should comment on areas within their expertise, and may choose to abstain from other areas including restricting your technical comments to your area of expertise, but feel free to render opinions or raise questions about larger scientific issues that may be relevant. To the extent possible, justify your comments with supporting evidence just as you would do when presenting your own scientific work. Please do not refrain from offering relevant opinions, but also label them as such. Test your comments for fairness, objectivity and tone of delivery by asking yourself if you would be comfortable presenting your comments, face-to-face, to the author and a panel of your peers.

Questions for Peer Review

Available Data

1. Please identify any oversights or omissions of data or information, and their relevance to the assessment. Are there others sources of information or studies that were not included that are relevant to assessing the viability of this species? What are they are how are they relevant?

2. Provide advice on the overall strengths and limitations of the scientific data used in the document. Have the authors been explicit about assumptions and limitations of, and concerns regarding, the data, and are these appropriately qualified or explained? Are there concerns that the Service did not identify, and if so, how relevant are these concerns to the assessment of viability of lynx in the contiguous U.S.? Are there any inconsistencies in how the data are presented or assessed?

Analysis of Available Data

3. Have the assumptions and methods used in the SSA report been clearly and logically stated in light of the best available information? If not, please identify the specific assumptions and methods that are unclear or illogical.

4. Are there demonstratable errors of fact or interpretation? Have the authors of the SSA report provided reasonable and scientifically sound interpretations and syntheses from the scientific information presented in the report? Are there instances in the SSA report where a different but equally reasonable and sound interpretation might be reached that differs from that provided by the Service? If any instances are found where this is the case, please provide the specifics regarding those particular concerns.

5. Provide feedback on the inclusion and portrayal of uncertainty in the SSA report. Have the scientific uncertainties present given the data and the analyses conducted been clearly identified and has the degree of uncertainty been appropriately characterized? If not, please identify any specifics concerns.

Text to be added to correspondence with Peer Reviewers:

The Species Status Assessment framework is a new tool the U.S. Fish and Wildlife Service is using to improve transparency while conducting listing determinations and other Act actions, and peer review of our analyses of the viability of species is part of that new process. As you will see, the attached draft SSA report is a rough draft; we are seeking your comments at this stage to ensure that we have time to incorporate any substantial comments as we finalize the report.

As you review the document, please note that this draft SSA report does not result in or predetermine a decision by the Service on whether the Canada lynx warrants protections of the s Act. This document is strictly a characterization of the viability species' viability in the contiguous United States.

As a reminder, all peer reviews and comments will be public documents, and portions may be incorporated verbatim into the Service's final decision Document, should there be one, with appropriate credit given to the author of the review. If you do not want your name to appear in a final decision document, as published in the Federal Register, please inform us of this as soon as possible.

In general we ask that your comments on the draft SSA report focus specifically on whether the best available information was used, the quality of the scientific information, and our interpretation and analyses of the data with regard to the species' viability in the contiguous United States. We request that you direct your review to the scientific issues and assumptions related to your expertise.

In accordance with the agreement terms and Performance Work Statement, the contractor(s) is (are) reminded of the requirements to protect information and that services shall consist of unbiased assessments through proper management and enforcement of scientific integrity standards, to avoid any conflict of interest.

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Task 5: The contracted project manager will provide all applicable official records to the Service project manager	42 (10 days)
Task 6: The project manager facilitates specific follow-up questions/answers between the Service and the reviewers, without attribution (task limited to a 10-day period, 30 days after delivering initial review comments to the Service).	60 (+15 days)
Task 7: Final report and official record is submitted to the Service	**70 (+ 10 days)**

7. Official Administrative Record
The preparation of an official administrative record is required.

8. Information Sources
The key information sources and links for this review will include: (1) the Draft Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx Canadensis, (2) the Final Report of the Canada Lynx Expert Elicitation Workshop, (3) the revised (Aug. 2013) interagency Lynx Conservation Assessment and Strategy (LCAS).

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From: Bush, Jodi
To: Steve Gess
Cc: Kaimy Marks
Subject: Re: Draft SOW for Lynx Peer Review
Date: Thursday, July 14, 2016 12:59:55 PM
Attachments: Final SOW Lynx SSA_July 15 2016 (2).doc

This looks fine Steve, although the time goes a little long. Guess we cant doe anything about that... Thanks for your help.

Kaimy use this version as what goes into PR. Appreciate your help. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Thu, Jul 14, 2016 at 7:27 AM, Steve Gess <Steve_Gess@fws.gov> wrote:

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Currently, there are five geographic areas known to support resident lynx populations in the DPS: northern Maine (with occasional/sporadic breeding by small numbers of lynx in northernmost New Hampshire and Vermont); northeastern Minnesota; northwestern Montana and northeastern Idaho; north-central Washington; and western Colorado. After statewide surveys conducted in 1978-1997 suggested the absence of viable resident lynx populations in Colorado, the State, from 1999 to 2006, released 218 lynx captured in Canada and Alaska into southwest Colorado to establish the current resident population. Additionally, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming is believed historically (and as recently as 2003-04) to have supported a small but relatively persistent lynx population, but it is uncertain whether it currently supports any resident lynx.

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1. A Ph.D. or an M.S. (with significant experience) in Wildlife Biology/Ecology, Ecology, or Wildlife Management or other related fields as long as they meet the other qualifications below.
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3. Expert knowledge of wildlife biology, wildlife management, demographic management of mammals (especially carnivores), wildlife population dynamics, and/or wildlife population modeling, as well as being generally versed in available literature on lynx and other carnivores, boreal forest systems, and changes in climate within boreal forest systems.
4. Expert knowledge of boreal forest ecosystems and effects of climate change within those ecosystems within Canada and the US is preferred.
5. Experience as a peer reviewer for scientific publications.

In addition, the reviewers must have no financial or other conflicts of interest with the outcome or implications of the report (reviewers should not be currently employed by the Service, State agencies within the lynx DPS range, or employed by (or contracted by) any organization that has either litigated or taken a position on lynx listing or recovery.

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Questions for Peer Review

Available Data

1. Please identify any oversights or omissions of data or information, and their relevance to the assessment. Are there others sources of information or studies that were not included that are relevant to assessing the viability of this species? What are they are how are they relevant?

2. Provide advice on the overall strengths and limitations of the scientific data used in the document. Have the authors been explicit about assumptions and limitations of, and concerns regarding, the data, and are these appropriately qualified or explained? Are there concerns that the Service did not identify, and if so, how relevant are these concerns to the assessment of viability of lynx in the contiguous U.S.? Are there any inconsistencies in how the data are presented or assessed?

Analysis of Available Data

3. Have the assumptions and methods used in the SSA report been clearly and logically stated in light of the best available information? If not, please identify the specific assumptions and methods that are unclear or illogical.

4. Are there demonstratable errors of fact or interpretation? Have the authors of the SSA report provided reasonable and scientifically sound interpretations and syntheses from the scientific information presented in the report? Are there instances in the SSA report where a different but equally reasonable and sound interpretation might be reached that differs from that provided by the Service? If any instances are found where this is the case, please provide the specifics regarding those particular concerns.

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As you review the document, please note that this draft SSA report does not result in or predetermine a decision by the Service on whether the Canada lynx warrants protections of the s Act. This document is strictly a characterization of the viability species' viability in the contiguous United States.

As a reminder, all peer reviews and comments will be public documents, and portions may be incorporated verbatim into the Service's final decision Document, should there be one, with appropriate credit given to the author of the review. If you do not want your name to appear in a final decision document, as published in the Federal Register, please inform us of this as soon as possible.

In general we ask that your comments on the draft SSA report focus specifically on whether the best available information was used, the quality of the scientific information, and our interpretation and analyses of the data with regard to the species' viability in the contiguous United States. We request that you direct your review to the scientific issues and assumptions related to your expertise.

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TLIN 002: Organizing, structuring, leading, and managing the scientific reviews and task order products.
TLIN 003: Managing and producing a final product.
TLIN 004: Responding to any follow-up questions from the Service on original review comments (not to exceed 10 consecutive days)
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TASK/DELIVERABLE	**CALENDAR DAYSAFTER AWARD**
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Task 2: The contractor(s) shall conduct a thorough, objective peer review of the Service's Species Status Assessment for the contiguous United States distinct	17 (14 days)

population segment (DPS) of the Canada lynx (Lynx Canadensis)	
Task 3: The contractor(s) will provide 3-5 expert peer reviews and a transmittal letter to the Service (to Regional Director, Noreen Walsh)	22 (5 days)
Task 4: The project manager facilitates specific follow-up questions/answers between the Service and the reviewers (task limited to a 10-day period, 60 days after delivering initial review comments to the Service).	32 (10 days)
Task 5: The contracted project manager will provide all applicable official records to the Service project manager	42 (10 days)
Task 6: The project manager facilitates specific follow-up questions/answers between the Service and the reviewers, without attribution (task limited to a 10-day period, 30 days after delivering initial review comments to the Service).	60 (+15 days)
Task 7: Final report and official record is submitted to the Service	**70 (+ 10 days)**

7. Official Administrative Record
The preparation of an official administrative record is required.

8. Information Sources
The key information sources and links for this review will include: (1) the Draft Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx Canadensis, (2) the Final Report of the Canada Lynx Expert Elicitation Workshop, (3) the revised (Aug. 2013) interagency Lynx Conservation Assessment and Strategy (LCAS).

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The payment schedule is as follows: 100 percent upon completion of Task 5 above.

10. Service Points of Contact:
Contracting Officer, Mr. Steve Gess (phone: 303-236-4334, or email: steve_gess@fws.gov).

Contracting Officer's Technical Expert: Jodi Bush (phone: 406-449-5225, ext.205 or email: Jodi_bush@fws.gov **Project Lead**: Jim Zelenak, **Mailing Address**: 585 Shepard Road, Suite 1, Helena, MT 59601 **Telephone**: 406-449-5225, ext. 220 **Email**: jim_zelenak@fws.gov

11. List of Enclosures/Attachments
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2. Final Report of the Canada Lynx Expert Elicitation Workshop
3. Revised (Aug. 2013) interagency Lynx Conservation Assessment and Strategy (LCAS).

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This requirement will be awarded based on best value. Best value will take into consideration price (to include the level of effort applied to each major task), approach (to include the labor categories, TLINs applied to each major task, and the reviewer's resumes (lynx or carnivore ecologist/researcher/manager/modeler having performed similar reviews) (reference paragraph 3).

Price must detail cost in accordance with the agreement. The approach must include a detailed/ proposed schedule (timeline), and the disciplines/skill mix of reviewers. The approach should be no more than 2 pages (8 1/2" x 11", 12 point font), excluding information on costs. All contractors must propose five reviewers. Be sure to include the discipline/skills of all reviewers (e.g., a resume or CV).

From:	Steve Gess
To:	Cusack, Matthew T
Cc:	Jodi Bush; Kaimy Marks
Subject:	Request for Proposal TASK ORDER= PEER REVIEW LYNX
Date:	Monday, July 18, 2016 9:00:32 AM
Attachments:	Final SOW Lynx SSA July 15 2016.doc RFP Atkins .docx

---

Matt, Here is a formal request for Proposal to conduct PEER review for LYNX study. Attached is the RFP , proposal is due August 12, 2016. Please let me know if you have any questions.

Steven C. Gess, CPPO
Contracting Officer
US Fish & Wildlife Service
Region 6 Lakewood CO.
303-236-4334
Steve_gess@fws.gov

United States Department of the Interior
FISH AND WILDLIFE SERVICE

Mountain-Prairie Region

134 Union Boulevard

Lakewood, CO 80228-1807

IN REPLY REFER TO:

BA/CGS
Mail Stop 60181

July 18, 2016

TRANSMITTED ELECTRONICALLY – NO HARD COPY TO FOLLOW

Attention: ATKINS – Matt Cusack

Subject: Request for Proposal, Reference Number 0718160008 for *Scientific Peer Review for LYNX*

PROPOSAL DUE DATE: August 12, 2016 C.O.B. (Close of Business)

The purpose of the letter is to request a proposal from your firm. The award of this requirement is s subject to the availability of funds. The Statement of Work entitled;" Peer Review (without attribution) of the Scientific Findings in U.S. Fish and Wildlife Service's Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis). Dated JULY 15, 2016

The Statement of Work and the following are enclosed for your review assistance in preparing your proposal.

1. 1) Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx Canadensis);
2. Final Report of the Canada Lynx Expert Elicitation Workshop
3. Revised (Aug. 2013) interagency Lynx Conservation Assessment and Strategy (LCAS).

The firm fixed priced order will be awarded based on ability to meet the requirement (Technical Expertise) and Reasonableness of Firm Fixed Price proposed. (Reference the Statement of Work, paragraph 12). Additional information may be requested and required to determine the best value to the Government.

In order to be responsive to this request for proposal the following must be submitted in accordance with the Statement of Work:

1. Price -total cost to perform peer review using 3-5 reviewers

2. Project Approach – Provide a detailed narrative limited to no more than 10 pages, which completely explains your approach to this project. Most notably how you plan to meet the detailed requirements of the OMB –"Final Information Quality Bulletin for PEER Review" (Dec 2004), specifically SECTION II: PEER REVIEW OF INFLUENTIAL SCIENTIFIC INFORMATION- for recruitment and selection of Qualified PEER reviewers and your approach to insuring the PEER review is properly executed.
3. PEER Reviewer Experience and Qualifications- SEE SOW- without names
4. Proposed Schedule which meets or exceeds our deadline of NLT October 15, 2016

If you require clarification or feedback as to this requirement and/or as to your assumptions please provide questions via email by August 3, 2016, 300 PM. Please feel free to contact me at (303) 236-4334 or via email at steve_gess@fws.gov

Sincerely,
/s/
Steven Gess
Contracting Officer

Order Statement of Work
Peer Review (without attribution) of the Scientific Findings in
U.S. Fish and Wildlife Service's Species Status Assessment for the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis).

Date: July 15, 2016

1. Introduction/Background

The U.S. Fish and Wildlife Service (Service) has conducted a species status assessment (SSA) as a first step to understand the current status of the contiguous United States distinct population segment (DPS) of the Canada lynx (Lynx canadensis), currently listed as threatened under the Endangered Species Act (Act). The SSA is intended to inform and streamline the court-ordered recovery plan (due January15, 2018), assuming such a plan is deemed necessary. The SSA report will also serve as the basis for the five-year status review (initiated in 2007; 72 FR 19549) required under the Act and would also provide the scientific foundation to support future rulemaking in accordance with the Act should the five-year review indicate that a change in the DPS's listing status is warranted.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the Act in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx and lynx habitats occurred on national forests, and that the Land and Resource Management Plans that guided management of those forests included "...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species" (65 FR 16052).

Currently, there are five geographic areas known to support resident lynx populations in the DPS: northern Maine (with occasional/sporadic breeding by small numbers of lynx in northernmost New Hampshire and Vermont); northeastern Minnesota; northwestern Montana and northeastern Idaho; north-central Washington; and western Colorado. After statewide surveys conducted in 1978-1997 suggested the absence of viable resident lynx populations in Colorado, the State, from 1999 to 2006, released 218 lynx captured in Canada and Alaska into southwest Colorado to establish the current resident population. Additionally, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming is believed historically (and as recently as 2003-04) to have supported a small but relatively persistent lynx population, but it is uncertain whether it currently supports any resident lynx.

In accordance with the Service peer review policy, we are requesting peer review of this species status assessment (SSA).

2. Description of Review

We are seeking peer review of this species status assessment (SSA). The purpose of the review is to help us ensure that we have used the best scientific and commercial information when we make our final decision as to the current status of the lynx. Thus, we are looking for independent scientific perspectives on the comprehensiveness and logic of the document, as well as how well

the technical conclusions are supported by the data and analyses. Peer reviewers should be advised that they are not to provide advice on policy.

3. Methods, Protocols and/or Scientific Standards

The selection of participants in a peer review is based on expertise, with due consideration of independence and conflict of interest (OMB –IQ bulletin for Peer Review). The most important factor in selecting reviewers is expertise: ensuring that the selected reviewer has the knowledge, experience, and skills necessary to perform the review. The independent peer reviewers shall be experienced senior-level ecologists, carnivore biologists, population modelers, and/or furbearer managers who have previously conducted similar reviews or regularly provided reviews of research and conservation articles for the scientific literature. Reviewers must be well-versed in the demographic management of mammals, preferably lynx or other carnivores. While expertise is the primary consideration, reviewers should also be selected to represent a diversity of scientific perspectives relevant to the subject.

Potential conflicts of interest include: employment or affiliation with the Service, the States, the Interagency Lynx Conservation Team, the Western Governors Association; peer reviewers who have offered a public opinion or a statement either for or against delisting; and peer reviewers directly or indirectly employed by or associated in any way with any organization that has either litigated the federal government concerning lynx or taken a position on one side or the other about recovery and listing of lynx. The contractor will be responsible for assigning an experienced, senior and well-qualified manager to lead this review and for the selection of 3-5 well-qualified, objective, independent reviewers (a minimum of 3 individuals must provide review; more is preferred). The expertise of qualified reviewers shall include at least 2 reviewers who meet criteria 1 and 2 and 4 below, and at least one reviewer who meets criteria 1 and 3 and 4: and representative of the DPS range of lynx including northeastern US, the Midwest, the Rocky Mtns and Canada.

1. A Ph.D. or an M.S. (with significant experience) in Wildlife Biology/Ecology, Ecology, or Wildlife Management or other related fields as long as they meet the other qualifications below.
2. Demonstrated experience working with the management of carnivores, especially lynx or other furbearers, and wildlife population management.
3. Expert knowledge of wildlife biology, wildlife management, demographic management of mammals (especially carnivores), wildlife population dynamics, and/or wildlife population modeling, as well as being generally versed in available literature on lynx and other carnivores, boreal forest systems, and changes in climate within boreal forest systems.
4. Expert knowledge of boreal forest ecosystems and effects of climate change within those ecosystems within Canada and the US is preferred.
5. Experience as a peer reviewer for scientific publications.

In addition, the reviewers must have no financial or other conflicts of interest with the outcome or implications of the report (reviewers should not be currently employed by the Service, State agencies within the lynx DPS range, or employed by (or contracted by) any organization that has either litigated or taken a position on lynx listing or recovery.

The Service will have an opportunity to seek clarification on any review comments through the contractor (Task 003.1), for a period of 10 days, starting 60 days after the Service receives the reviews from the contractor.

Peer Reviewers will provide individual, written responses. Peer Reviewers should be advised that their reviews, including their names and affiliations, will (1) be included in our administrative record, and (2) will be made available to the public. We will summarize and respond to the issues raised by the peer reviewers in the record.

Collectively, the review should cover, but not be limited to, the topics listed below. Individual reviewers should, at their own discretion, provide comments, criticisms, and ideas about any of the topics they feel qualified to comment on. The most valuable reviews will focus on how thoroughly and logically the topics have been treated, and how well the conclusions are supported by the data and analyses. Not all reviewers are required to address all issues noted below. Reviewers should comment on areas within their expertise, and may choose to abstain from other areas including restricting your technical comments to your area of expertise, but feel free to render opinions or raise questions about larger scientific issues that may be relevant. To the extent possible, justify your comments with supporting evidence just as you would do when presenting your own scientific work. Please do not refrain from offering relevant opinions, but also label them as such. Test your comments for fairness, objectivity and tone of delivery by asking yourself if you would be comfortable presenting your comments, face-to-face, to the author and a panel of your peers.

Questions for Peer Review

Available Data

1. Please identify any oversights or omissions of data or information, and their relevance to the assessment. Are there others sources of information or studies that were not included that are relevant to assessing the viability of this species? What are they are how are they relevant?

2. Provide advice on the overall strengths and limitations of the scientific data used in the document. Have the authors been explicit about assumptions and limitations of, and concerns regarding, the data, and are these appropriately qualified or explained? Are there concerns that the Service did not identify, and if so, how relevant are these concerns to the assessment of viability of lynx in the contiguous U.S.? Are there any inconsistencies in how the data are presented or assessed?

Analysis of Available Data

3. Have the assumptions and methods used in the SSA report been clearly and logically stated in light of the best available information? If not, please identify the specific assumptions and methods that are unclear or illogical.

4. Are there demonstratable errors of fact or interpretation? Have the authors of the SSA report provided reasonable and scientifically sound interpretations and syntheses from the scientific information presented in the report? Are there instances in the SSA report where a different but equally reasonable and sound interpretation might be reached that differs from that provided by the Service? If any instances are found where this is the case, please provide the specifics regarding those particular concerns.

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From: Willey, Seth
To: Bush, Jodi
Cc: Jacobsen, Dana
Subject: Re: [Lynx RP] Draft status report
Date: Tuesday, December 30, 2014 2:26:37 PM

Not sure this matters too much and probably too late, but not sure #3 is how I would word it. First, is it really guidance? I think of guidance as more like policy direction and such. Second, the use of past tense makes it sound finished, when it is not. Perhaps misleading. Perhaps alternative language could be :

"The office tasked with leading the development of the recovery plan has begun the process of developing a road map to guide the recovery planning process. This document will clarify the roles and responsibilities of all involved parties and expected timelines."

My two cents, but not that big of a deal.

Seth

****
Seth L. Willey
Assistant Regional ESA Chief &
Regional Recovery Coordinator
USFWS, Mountain-Prairie Region
Seth_Willey@fws.gov
303-236-4257
****

On Tue, Dec 23, 2014 at 8:43 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> nope
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Mon, Dec 22, 2014 at 8:14 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
>
> > Hey there, any comments?
> > ---------- Forwarded message ----------
> > From: **Annatoyn, Travis (ENRD)** <Travis.Annatoyn@usdoj.gov>
> > Date: Mon, Dec 22, 2014 at 11:32 AM
> > Subject: [Lynx RP] Draft status report
> > To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>

Hi Dana:

Draft with a few edits. Pending any input on your end, I'll file on NYE.

Thanks,

Travis Annatoyn, Trial Attorney

United States Department of Justice

Environment and Natural Resources Division

601 D St. NW

Washington, D.C. 20004

travis.annatoyn@usdoj.gov

Tel: 202-514-5243

Fax: 202-305-0275

--
Dana Jacobsen
Assistant Regional Solicitor
Rocky Mountain Regional Office
Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 231-5353 x 336

SAM HIRSCH
Acting Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON, Assistant Chief
TRAVIS ANNATOYN, Trial Attorney
U.S. Department of Justice
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Washington, D.C. 20044-7611
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travis.annatoyn@usdoj.gov

Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014 (ECF No. 30), Federal Defendants hereby submit the following status report concerning the Fish and Wildlife Service's ("Service") progress towards completion of a recovery plan for

the Canada lynx under 16 U.S.C. § 1533(f).

1. On September 12, 2104, the Service designated critical habitat for the Canada lynx. See 79 Fed. Reg. 54782-01. This designation is the subject of two pending lawsuits, including a suit brought by Plaintiff Rocky Mountain Wild. See Alliance for the Wild Rockies v. Bean, 9:14-cv-00272-DLC (D. Mont.); WildEarth Guardians v. U.S. Dept. of Interior, 9:14-cv-00270-DLC (D. Mont.).

2. The Montana Ecological Services Office (the lead office for development of the Recovery Plan) has sent letters to several States, Federal agencies, Tribes and other interested parties requesting input on the best available information for both lynx recovery planning and the five-year status review for the lynx. See 16 U.S.C. § 1533(c)(2). The five-year review process will clarify the extent, magnitude, and nature of threats to the species so that recovery planning may target any such threats. The Service intends to begin review of the information in its records and gathered from its partners within the next six months.

3. The Service is now guidance for completion of a recovery plan for Canada lynx. This guidance clarifies responsibilities, timetables, and budgets for lynx recovery planning.

DATED: December 31, 2014

Respectfully submitted,

SAM HIRSCH
Acting Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
TRAVIS ANNATOYN, Trial Attorney
New York Bar ID 4983730
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
(202) 514-5243 (tel)
(202) 305-0275 (fax)
travis.annatoyn@usdoj.gov

Attorneys for Federal Defendants

From: McCollough, Mark
To: Zelenak, Jim; Laury Zicari
Subject: Re: Friends of lynx critical habitat?
Date: Friday, April 24, 2015 1:30:28 PM

Thanks Jim.

Please keep this under wraps as it is not official yet...

We met with the MDIFW this afternoon to discuss the next steps with their trapping HCP. As you may recally, 2 lynx were killed in conibear traps on leaning pole sets last fall, leaving only one permitted lethal take for the next 15 years.

Based on the evidence that lynx climb leaning poles, MDIFW will propose regulations that would require exclusion devices for all upland conibear traps in lynx areas (except blind sets). Also, based on their experience with injuries to lynx in foothold traps, MDIFW will propose regulations requiring that there be three swivels on the chains for all foothold traps and that the area be cleared of all debris within the diameter of the staked chains.

MDIFW had questions about the SSA, 5-year review, and recovery plan. They want to be involved. Fortunately, Laury had a copy of the draft memo from Jody Bush concerning the sequence of events over the next few months. We did not share the draft memo with MDIFW, but did let them know there would be opportunities for their involvement when we do the workshops in May and June. They wanted a list of all of the states within the lynx DPS. Perhaps (not certain?) they may contact other state wildlife agencies?

Have a good weekend.

Mark

On Fri, Apr 24, 2015 at 3:05 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Washington State Snowmobile Association, which sued us and won on economics for 2009 CH, has teamed up with the American Petroleum Institute (API) to help us defend the 2014 designation against WildEarth Guardians et al. They requested permission to file an amicus brief which we/DOJ did not oppose, and the court granted.
>
> Odd.
>
> Let me know if you'd like a copy of the court order granting it.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--

Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Parkin, Mary
To: Jim Zelenak
Cc: Jodi Bush
Subject: Re: Accepted: Weekly lynx SSA coordination call: 11-12 MT @ Mon Jun 1, 2015 1pm - 2pm (mary_parkin@fws.gov)
Date: Friday, May 29, 2015 8:35:38 AM

Hey both,

Great job on the kickoff call yesterday! What came across to me is that a lot of thought and preparation has gone into organizing the process, and I'm surmising that folks are going to take it seriously because of that (and the court-ordered deadline, of course).

We'll talk on Monday, Jim. In the meantime, have a great weekend,
Mary

On Fri, May 29, 2015 at 9:39 AM, Jim Zelenak <jim_zelenak@fws.gov> wrote:

> **Jim Zelenak has accepted this invitation.**
>
> **Weekly lynx SSA coordination call: 11-12 MT**
>
> When Mon Jun 1, 2015 1pm – 2pm Eastern Time
>
> Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin
>
> Calendar mary_parkin@fws.gov
>
> Who
> - Mary Parkin - organizer
> - Jim Zelenak
> - Heather Bell
>
> Invitation from Google Calendar
>
> You are receiving this email at the account mary_parkin@fws.gov because you are subscribed for invitation replies on calendar mary_parkin@fws.gov.
>
> To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Zelenak, Jim
To: Jacobsen, Dana
Cc: Jodi Bush; Brent Esmoil
Subject: Re: [Lynx RP] Status update
Date: Thursday, June 18, 2015 1:35:25 PM

Yes, please.

I will use that template to provide an update - final lynx SSA project plan, intra-agency kick-off call and establishment of monthly coordination calls, core and implementation team formation and weekly/biweekly calls, coordination with states and other partners, etc.

Think it can be put together quickly.

Thanks Dana!

On Thu, Jun 18, 2015 at 1:21 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

> Hi all,
>
> I know Jodi is out a bit this week and next, so I am also writing to Brent and Jim. We have to prepare a status report for lynx recovery planning. Would it help if I sent the last status report as a starting place?
>
> Dana J.
>
> ---------- Forwarded message ----------
> From: **Annatoyn, Travis (ENRD)** <Travis.Annatoyn@usdoj.gov>
> Date: Thu, Jun 18, 2015 at 1:08 PM
> Subject: [Lynx RP] Status update
> To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>
>
> Hi Dana:
>
> It's that time again: we have a status report due to the Court on July 1st re: the progress of recovery planning. Could we get an update by next Wed. or so?
>
> Thanks!
>
> Travis Annatoyn, Trial Attorney
>
> United States Department of Justice

Environment and Natural Resources Division

601 D St. NW

Washington, D.C. 20004

travis.annatoyn@usdoj.gov

Tel: 202-514-5243

Fax: 202-305-0275

--
Dana Jacobsen
Assistant Regional Solicitor
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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Jacobsen, Dana
To:	Jodi Bush; Brent Esmoil; Jim Zelenak
Subject:	Fwd: [Lynx RP] Status update
Date:	Thursday, June 18, 2015 1:21:44 PM

Hi all,

I know Jodi is out a bit this week and next, so I am also writing to Brent and Jim. We have to prepare a status report for lynx recovery planning. Would it help if I sent the last status report as a starting place?

Dana J.

---------- Forwarded message ----------
From: **Annatoyn, Travis (ENRD)** <Travis.Annatoyn@usdoj.gov>
Date: Thu, Jun 18, 2015 at 1:08 PM
Subject: [Lynx RP] Status update
To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>

Hi Dana:

It's that time again: we have a status report due to the Court on July 1st re: the progress of recovery planning. Could we get an update by next Wed. or so?

Thanks!

Travis Annatoyn, Trial Attorney

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1. On January 13, 2015, the Service prepared and disseminated a news release announcing its intent to conduct a five-year review for Canada lynx in preparation for recovery planning, and soliciting pertinent information from the public (http://www.fws.gov/mountain-prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php).

2. In March, 2015, the Service determined that it will apply its relatively new Species Status Assessment (SSA) framework to the lynx DPS prior to completing the court-ordered recovery plan, a five-year review, or other decision documents required under the ESA. The SSA is a structured, transparent, and scientifically-robust status, threat, and viability assessment that is intended to provide the scientific underpinnings for all determinations the Service is required to make in accordance with the Act (e.g., listing decisions, status reviews, critical habitat designations, and recovery plans). By providing all the species-specific science in a single document that can be updated as new information becomes available, the SSA report is intended to streamline, expedite, and reduce the size and complexity of *Federal Register* notices associated with determinations required by the Act, while simultaneously separating the science from the policy and decision-making process.

3. On April 29-30, 2015, the Service's Region 6 Regional Office in Lakewood, Colorado, hosted an SSA workshop that presented information and discussion on how to initiate application of the framework and development of robust project plans for SSAs for a number of listed species in Region 6, including the lynx DPS.

4. On May 28, 2015, the Service's Montana Ecological Services Field Office (MTFO) conducted a "kick-off" call with other Service Regions and Field Offices within the lynx DPS range to announce initiation of the SSA process for the DPS and to assign a core team of Service biologists throughout the DPS range to commit to participation in the SSA and subsequent recovery planning processes.

5. On June 1, 2015, the MTFO initiated weekly calls with an intra-Service SSA Framework Implementation Team assigned to guide the lynx SSA. These weekly calls are expected to continue until the SSA report is completed (target date is December, 2015).

6. On June 11, 2015, the MTFO initiated biweekly calls with an intra-Service SSA "Core Team" of biologists assigned to participate in and complete the lynx SSA and subsequent recovery plan. These biweekly calls are expected to continue until the SSA report and recovery planning process are completed.

7. On June XX, 2015 (pending), the MTFO finalized the project plan (enclosed [?]) for the lynx SSA, after incorporating comments provided on the draft plan by other Regions and Field Offices. The project plans outlines the SSA and subsequent recovery planning activities, the levels of necessary coordination with State, Tribal, public, and other Federal partners, and time lines and major milestones for completing the SSA and subsequent recovery planning and other documents required under the ESA.

8. On June XX, 2015 (pending) the Service sent update letters to State wildlife management agencies throughout the DPS range to inform them of the initiation of the SSA process and to commit to continued coordination with the States.

From: Bush, Jodi
To: Zelenak, Jim
Cc: Jacobsen, Dana; Brent Esmoil; Seth Willey
Subject: Re: Lynx Recovery Planning: Draft Status Report
Date: Monday, June 22, 2015 1:24:50 PM

---

this looks good to me with edits. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Jun 22, 2015 at 12:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> I had just a few edits/suggestions.
>
> On Mon, Jun 22, 2015 at 11:29 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
>
> > Edit away, Jim! I will then pass to Travis at DOJ.
> >
> > --
> > Dana Jacobsen
> > Assistant Regional Solicitor
> > Rocky Mountain Regional Office
> > Office of the Solicitor
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>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
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> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

From: Zelenak, Jim
To: Jacobsen, Dana
Cc: Jodi Bush; Brent Esmoil; Seth Willey
Subject: Re: Lynx Recovery Planning: Draft Status Report
Date: Monday, June 22, 2015 1:32:57 PM

22.

On Mon, Jun 22, 2015 at 12:58 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

> Great, thanks, Jim! How many comments/inquiries/letters with information did you all get as a result of the press release? I think that might be worthy of adding to the status report.
>
> On Mon, Jun 22, 2015 at 12:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > I had just a few edits/suggestions.
> >
> > On Mon, Jun 22, 2015 at 11:29 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
> >
> > > Edit away, Jim! I will then pass to Travis at DOJ.
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> > > --
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Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014 (ECF No. 30), Federal Defendants hereby submit the following status report concerning the Fish and Wildlife Service's ("Service") progress towards completion of a recovery plan for

the Canada lynx under 16 U.S.C. § 1533(f).

1. On January 13, 2015, the Service issued a news release announcing its intent to conduct a five-year review for Canada lynx in preparation for recovery planning. The Service solicited information from the public when it issued its news release. *See* http://www.fws.gov/mountain-prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php). The Service requested that information and comments be provided to the Service by February 1, 2015. The Service received twenty-two comment letters in response to the request for information.

2. In March, 2015, the Service determined that it will apply its Species Status Assessment (SSA) framework to inform the recovery planning process for Canada lynx. The SSA is a structured, transparent, and scientifically-robust status, threat, and viability assessment that is intended to provide the scientific underpinnings for determinations the Service is required to make in accordance with the Act (e.g., listing decisions, status reviews, critical habitat designations, and recovery plans).

3. On April 29-30, 2015, the Service's Region 6 Regional Office in Lakewood, Colorado, hosted an SSA workshop involving the Service and staff from the U.S. Geological Survey (USGS) that presented information and discussion on how to initiate application of the framework and development of robust project plans for SSAs for a number of listed species in Region 6, including for Canada lynx.

4. On May 28, 2015, the Service's Montana Ecological Services Field Office (MTFO) conducted a call with other Service Regions and Field Offices within the range of the lynx to announce initiation of the SSA process for the Canada lynx and to assign a core team of Service biologists to commit to participation in the SSA and associated recovery planning processes.

5. On June 1, 2015, the MTFO initiated weekly calls with a FWS and USGS SSA Framework Implementation Team assigned to guide the lynx SSA. These weekly calls are expected to continue until the SSA report is completed (target date is December, 2015). The SSA report will inform recovery planning for Canada lynx.

6. On June 11, 2015, the MTFO initiated biweekly calls with an intra-Service SSA "Core Team" of biologists assigned to participate in and complete the lynx SSA and subsequent recovery plan. These biweekly calls are expected to continue until the SSA report and recovery planning process are completed.

DATED: July 1, 2015

Respectfully submitted,

SAM HIRSCH
Acting Assistant Attorney General
SETH M. BARSKY, Chief

KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014 (ECF No. 30), Federal Defendants hereby submit the following status report concerning the Fish and Wildlife Service's ("Service") progress towards completion of a recovery plan for

the Canada lynx under 16 U.S.C. § 1533(f).

1. On January 13, 2015, the Service issued a press release announcing a five-year status review for Canada lynx in preparation for recovery planning. See Ex. 1. In conjunction with this release, the Service requested public comment before February 1, 2015, and received 22 comment letters in response.

2. In March, 2015, the Service determined to apply its Species Status Assessment framework to recovery planning for Canada lynx. The Species Status Assessment is a structured, transparent, and scientifically-robust status, threat, and viability assessment intended to provide support for the Service's scientific determinations under the Act (*e.g.*, listing decisions, status reviews, critical habitat designations, and recovery plans).

3. On April 29-30, 2015, the Service's Region 6 Regional Office in Lakewood, Colorado, hosted a Species Status Assessment workshop. The workshop was attended by staff from the United States Geological Survey ("USGS"), who led discussion on application of the Assessment to several species in Region 6, including the Canada lynx.

4. On May 28, 2015, the Service's Montana Ecological Services Field Office ("Field Office") led a call attended by various Service subdivisions within the lynx's range. During the call, the Field Office announced application of the Species Status Assessment to the Canada lynx and assigned a "Core Team" of

Service biologists to recovery planning. This team will complete the lynx Species Status Assessment and subsequent recovery plan.

5. On June 1, 2015, the Field Office initiated weekly calls with a Framework Implementation Team – comprised of Service and USGS personnel – that will oversee the lynx Species Status Assessment. These calls are likely to continue until the Assessment report is completed. The Assessment report will inform recovery planning for Canada lynx.

6. On June 11, 2015, the Field Office initiated biweekly calls with the intra-Service "Core Team." These calls are likely to continue until recovery planning is completed.

DATED: July 1, 2015

Respectfully submitted,

JOHN C. CRUDEN
Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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Attorneys for Federal Defendants

From: Zelenak, Jim
To: Bush, Jodi
Cc: Jacobsen, Dana; Seth Willey
Subject: Re: Status Report: Canada lynx, Recovery Planning
Date: Monday, June 29, 2015 8:22:30 AM

Looks good to me, too.

Jodi and I don't think it needs further FWS review. Seth? Do you think Mike wants/needs to take a look before it is submitted to the court?

Thanks Dana.

Jim

On Mon, Jun 29, 2015 at 8:16 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> looks fine to me. JB
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Mon, Jun 29, 2015 at 8:15 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
>
> > HI all,
> >
> > Attached is another draft that contains DOJ's comments. Let me know if you have any comments!
> >
> > And, please forward to anyone else in FWS that would like to/wants to review the draft.
> >
> > Thanks.
> >
> > Dana J.
> >
> > --
> > Dana Jacobsen
> > Assistant Regional Solicitor
> > Rocky Mountain Regional Office
> > Office of the Solicitor
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--
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Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014 (ECF No. 30), Federal Defendants hereby submit the following status report concerning the Fish and Wildlife Service's ("Service") progress towards completion of a recovery plan for

the Canada lynx under 16 U.S.C. § 1533(f) for the period from July 2, 2015 to December 31, 2015.

1. In July, 2015, the Service informed State wildlife management agencies of ~~the~~ its decision to conduct a Species Status Assessment ("SSA") for the Canada lynx Distinct Population Segment (DPS) and outlined opportunities for State participation.

2. From July, 2015 through December, 2015, the Service held weekly calls with the Lynx SSA Framework Implementation Team (which will oversee development and completion of the SSA); biweekly calls with the SSA Core Team (which will draft the SSA report and associated documents); and monthly calls with both Service field offices and State agency partners.

3. On October 13, 2015 through October 15, 2015, the Service convened an Expert Elicitation Workshop in Minneapolis, Minnesota, attended by most agency and academic lynx and snowshoe hare researchers (including researchers from southern Canada), forest and climate modelers, and observers from State agency partners. The Workshop facilitated an exchange of expert opinions on (1) aspects of lynx biology for which empirical data ~~is~~ are lacking; and (2) factors likely to influence the future viability of lynx populations within the DPS. The Service compiled detailed notes of the workshop, which were subsequently shared with and reviewed by Workshop

participants. The Service is now preparing a report analyzing and summarizing the Workshop, which will ultimately inform the S~~A~~SA.

DATED: {date}.

Respectfully submitted,

JOHN C. CRUDEN
Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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FOR THE DISTRICT OF MONTANA
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FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
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Pursuant to the Court's order of June 25, 2014 (ECF No. 30), Federal Defendants hereby submit the following status report concerning the Fish and Wildlife Service's ("Service") progress towards completion of a recovery plan for

the Canada lynx under 16 U.S.C. § 1533(f).

1. In July, 2015, the Service informed State wildlife management agencies of the decision to conduct a Species Status Assessment ("SSA") for the Canada lynx Distinct Population Segment and outlined opportunities for State participation.
2. From July, 2015 through December, 2015, the Service held weekly calls with the Lynx SSA Framework Implementation Team (which will oversee development and completion of the SSA); biweekly calls with the SSA Core Team (which will draft the SSA and associated documents); and monthly calls with both Service field offices and State agency partners.
3. On October 13, 2015 through October 15, 2015, the Service convened an Expert Elicitation Workshop in Minneapolis, Minnesota, attended by most agency and academic lynx and snowshoe hare researchers (including researchers from southern Canada), forest and climate modelers, and observers from State agency partners. The Workshop facilitated an exchange of expert opinions on (1) aspects of lynx biology for which empirical data is lacking; and (2) factors likely to influence the future viability of lynx populations. The Service compiled detailed notes of the workshop, which were subsequently shared with and reviewed by Workshop participants. The Service is now preparing a report analyzing and summarizing the Workshop,

which will ultimately inform the SAS.

DATED: {date}.

Respectfully submitted,

JOHN C. CRUDEN
Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014 (ECF No. 30), Federal Defendants hereby submit the following status report concerning the Fish and Wildlife Service's ("Service") progress towards completion of a recovery plan for

the Canada lynx under 16 U.S.C. § 1533(f) for the period from July 2, 2015 to December 31, 2015.

1. In July, 2015, the Service informed State wildlife management agencies of ~~the~~ its decision to conduct a Species Status Assessment ("SSA") for the Canada lynx Distinct Population Segment (DPS) and outlined opportunities for State participation. The SSA will use the best available scientific information and expert opinion to evaluate the current status and future viability of the DPS to inform recovery planning.
2. From July, 2015 through December, 2015, the Service held weekly calls with the Lynx SSA Framework Implementation Team (which will oversee development and completion of the SSA); biweekly calls with the SSA Core Team (which will draft the SSA report and associated documents); and monthly calls with both Service field offices and State agency partners.
3. On October 13, 2015 through October 15, 2015, the Service convened an Expert Elicitation Workshop in Minneapolis, Minnesota, attended by most agency and academic lynx and snowshoe hare researchers (including researchers from southern Canada), forest and climate modelers, and observers from State agency partners. The Workshop facilitated an exchange of expert opinions on (1) aspects of lynx biology for which empirical data ~~is~~ are lacking; and (2) factors likely to influence the future viability of lynx

populations within the DPS. The Service compiled detailed notes of the workshop, which were subsequently shared with and reviewed by Workshop participants. The Service is now preparing a report analyzing and summarizing the Workshop, which will ultimately inform the SASA.

DATED: {date}.

Respectfully submitted,

JOHN C. CRUDEN
Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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Attorneys for Federal Defendants

From:	Bush, Jodi
To:	Dana Jacobsen; Annatoyn, Travis (ENRD)
Subject:	Fwd: Lynx Rec update to court
Date:	Friday, March 25, 2016 1:05:49 PM
Attachments:	2015 12 17 DRAFT WILDLIFE-#283346-v1-Lynx_Status_Report_1_1_16 jz edits V2.doc

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Do either of you have the last report we made to plaintiffs on the Lynx Recovery case? We just have a draft and probably need final for records. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
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(406) 449-5225, ext.205

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Fri, Mar 25, 2016 at 9:16 AM
Subject: Lynx Rec update to court
To: Jodi Bush <jodi_bush@fws.gov>

Looking through my files I realized I never got the final Jan. 2016 update to the court from Travis/Dana.

Attached here is the last version I had with my last edits/comments.

I'll email Travis and Dana to see if we can get the final as submitted to the court for our records, unless you would prefer to do that. Let me know.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: Mark in midst of move
Date: Thursday, June 02, 2016 4:18:27 PM

Jim:

I believe the final ch rule has a discussion of unique deep snow conditions in 2008 and 2009, our hypothesis concerning bobcat decline and lynx range expansion, hare decline prompting lynx dispersal, and uncertainty about how long lynx would persist in VT and NH.

We have good data from NH for each of the last few winters (map I sent you recently) from Alexej's report. But there has not been similar reports for VT. I believe you are correct that lynx have not been detected in VT for several years.

I will originate a request to the refuge manager and biologist so we have better documentation of what has happened in VT.

thanks, Mark

On Thu, Jun 2, 2016 at 4:11 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Thanks, Mark. I appreciate the support and will keep EAP in mind if things persist or get worse. I have mentioned my concerns about constant stress and unreasonable time lines to both my direct supervisor and to Jodi. I am trying to take care of myself, though I've gotten a bit off my exercise routine of late. I do make it a priority to spend time with Abby, but I have not been fishing yet this year and I am not always successful (maybe even rarely so) at leaving work at work. Need to work on that.
>
> I also agree with your thoughts on the SSA process.
>
> Anyway, at the moment, I do have an SSA-related question for you. I'm trying to remember if we (you) wrote down anywhere a conversation I'm sure we had regarding the VT/NH lynx, and how that was likely a temporary thing because a few successive hard winters knocked back the bobcats, making occupancy by lynx possible. Do you recall writing any of that down?
>
> Also, I believe you told me that although surveys have continued in VT since breeding lynx were last detected (in the final CH rule we said they were found in 2009, 2011, and 2012), none have been found in the last few years. Is that documented anywhere - survey results from Nulhegen maybe? Or by Vermont Fish and Game?
>
> Let me know. thanks,
>
> Jim
>
> On Wed, Jun 1, 2016 at 8:31 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Jim:
> >
> > It seems like these stories of overwork and unmanageable deadlines are all too frequent these days. They keep telling us to do less with less - but that is not the reality. The lynx burned out a couple of people before you, so be careful. Try to take care of yourself. I went to EAP (as did my supervisor) two years ago when the workload was similarly ridiculous with the lynx trapping HCP. It really helped, and I would highly advise EAP. Its a free service to each of us. My coach/advisor helped me put work into perspective and showed me that I had to do what was moral and ethically right - maintain scientific integrity and keep careful notes and document our decisions per our administrative record

and decision file policies. She also helped me to develop a work-life balance. She helped me understand that some of the health problems I was developing were because of work. I have to say, I feel much better and "balanced" these days.

So, each day when you leave the office, really leave it behind. Spend quality time with your daughter. Go fishing... I call my garden my "psychiatrist" and spend time there each evening this time of year taking care of plants, trees, enjoying the birds, splitting wood for next winter.

I think of the many months we spent doing SSA exercises when we could have been writing. I'm not sure how useful all those exercises were. Perhaps they would be useful to develop models and biological relationships for a relatively unknown candidate species, but they did not contribute much additional knowledge to our understanding of the lynx.

At any rate, we are temporarily out of moving crates, so it looks I can put some time in on the SSA this afternoon.

Stay positive!

Mark

On Wed, Jun 1, 2016 at 9:46 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Really sorry to hear what you are having to go through and deal with there, Mark. I feel angry on your behalf, though I'm sure that's little consolation. If nothing else, fodder for the "employee viewpoint" survey or whatever the hell they are calling it these days.
>
> I appreciate all your work on the SSA report - you have done the lion's share of the writing so far; I hope to catch up soon and get my sections written, though I'm finding it difficult writing; trying to tell the story in a way that is accurate, makes sense, and will be useful for decision makers. It burns me a little bit when the SSA implementation folks suggests that it's really not complicated or complex. Yes, it's a fairly simple biological system of boreal forest, snow and hares, but even McKelvey in one of his chapters outlined the difficulties in trying to understand and articulate the system and develop an appropriate conservation approach.
>
> I also struggle with what exactly is desired and I'm uncertain if we are hitting the mark or not. But, I agree that we've made progress. Although it's been a little over a year since we learned we would have to go through this process, remember how much time was spent developing the plan, getting necessary signatures at several levels, contacting and arranging regular communication across our agency and with all interested states/AFWA, how much time we spent developing a "white paper" strategy outlining appropriate state input, then all the time identifying, contacting, and making arrangements for experts to attend the workshop, developing all the materials for the workshop (CMs, questions for the 3rs, etc.), the time spent turning the outcome of the workshop into a cohesive report, etc., etc. On top of all that, our direction has changed a couple times out of my RO and here - "we're doing a 5-year review first" (we announced that to the whole world), "no we're not, we don't have a court order for that, only the recovery plan, but we need to 'do' an SSA". Jim: "what's an SSA and who knows how to do one?" They: :"well, it's new and really cool, but still a work/idea in progress, so just bear with us and we'll get you through it...", and on and on.....
>
> The same folks at my RO who agreed to a pretty quick time line for the court-ordered recovery plan were clearly not thinking then about the need for an SSA or allowing room in the time line for one, but a month or so after the court timeline was finalized, I got the news that we would have to do this SSA. I try to be receptive to change and to understand and make the best of moving targets, open to new ideas/processes, willing to work extra hours and "take one for the team" when necessary, but in this case I'm pretty fried, feel like I've been under fairly constant stress for most of the past 1.5 years with this thing and with all the effort

on the CH lawsuit and responses, etc., and I do not see the stress relenting until a recovery plan is done. I'm not willing to spend the rest of my Service career, likely 12-14 years, under this kind of constant pressure and stress. It has been spilling over into my family life, and I'm not willing to have that continue to be the case.

Well, my intent was to be supportive but instead I've gone on a rant of my own. Sorry about that Mark. I do commiserate with your situation, and I hope this seemingly unnecessary transition is over soon and you can settle into a more comfortable routine.

Thanks again for making the SSA work a priority despite all the other things that you have going on.

Hang in there.

jim

On Wed, Jun 1, 2016 at 6:13 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Jim: Our world is being turned upside down here. The Service did not have enough funds to move our office, so they have asked us to do most of the packing. Thus, my office (including all my lynx papers) is quickly disappearing into packing crates. Unfortunately, this will reduce the amount of time that I can help with the lynx SSA for the next two to three weeks.
>
> I will be able to work on my sections in the SSA some today and tomorrow. Our servers and phones will be disconnected by the end of the week. Movers will be here next week (June 6) carting it all away. I plan to set up a home office early next week. If all goes well with internet connection, I should be able to put some time in on the SSA from home next week (and participate in the call on Tuesday). The following week (June 13) we are expected to show up at the hatchery (with smiley faces) and unpack it all.
>
> We are making progress, but I'm not sure what the SSA experts want. It seemed on our call last week that Heather was disappointed with what we had produced. On one hand they say they want an SSA that captures all we know about the species, and on the other they seem to want something much more brief with lots of flow charts and graphs.
>
> I think we have made amazing progress. Especially when you think about how much time it took for ~15 people to contribute toward and write the LCAS (over a year).
>
> Hang in there...you are doing a great job!
>
> Mark
> --
> **Mark McCollough, Ph.D.**
> **Endangered Species Specialist**
> **US Fish and Wildlife Service**
> **Maine Fish and Wildlife Service Complex**
> **Ecological Services**
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From:	Zelenak, Jim
To:	Solberg Schwab, Lisa
Subject:	Re: Lynx SSA
Date:	Thursday, October 20, 2016 12:49:28 PM
Attachments:	2016 10 14 DRAFT Lynx SSA Report CLEAN.docx

Sorry I had to bail on our call, Lisa.

Now I have a meeting/training the rest of today.

I've attached the DRAFT SSA report and I welcome your thoughts/comments. This is currently out for internal FWS review and will later go out for peer review and partner review, so please don't distribute this elsewhere.

I will send out a notice soon about the next internal coordination call (Nov. 1).

Let me know if you have questions.

Jim

On Thu, Oct 20, 2016 at 11:15 AM, Solberg Schwab, Lisa <lisa_solbergschwab@fws.gov> wrote:

> Jim,
>
> Is it possible for me to see a copy of the Lynx SSA, I know I'm not on the core team but I'd like to know whats going on. Also at some point the BLM in WY wanted to be able to provide comments. I don't know if now is the right time or if there will be another comment period, I just thought I'd let you know.
> thanks a lot!
> Lisa Solberg Schwab
> Biologist
> USFWS, Wyoming ES Field Office
> located at
> BLM Pinedale Field Office
> 1625 W. Pine St.
> P.O. Box 768
> Pinedale, WY 82941
> (307) 367-5340

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Species Status Assessment

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment



Photo by Keith Williams

Version 2.0 - Draft
~~September~~ October 2016

U.S. Fish and Wildlife Service
Regions 1, 3, 5 and 6

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Executive Summary

Background

This report presents the results of a species status assessment (SSA) conducted for the contiguous United States distinct population segment (DPS) of Canada lynx (*Lynx canadensis*). The DPS was listed in 2000 as threatened under the Endangered Species Act (ESA) because of the inadequacy of regulatory mechanisms on federal lands. The SSA will provide the scientific basis for the statutorily required 5-year status review for this listed species and other decisions the Service is required to make in accordance with the ESA. The SSA provides an evaluation of the current and future status of lynx in six geographic units within the DPS that currently support or recently supported resident breeding populations. The units are distr buted across the northern contiguous U.S. from Maine to Washington and south along the Rocky Mountains to western Colorado. These geographic units combined represent approximately the southern two percent of the species' entire breeding range (ninety-eight percent occurs in Canada and Alaska). The units are relatively isolated from each other, although four of the six units are directly connected to lynx populations and habitats in Canada. These SSA geographic units are:

Unit No.	Name	Size (km^2)
Unit 1	Northern Maine	28,909
Unit 2	Northeastern Minnesota	21,101
Unit 3	Northwestern Montana/Northeastern Idaho	26,997
Unit 4	North-central Washington	5,176
Unit 5	Greater Yellowstone Area	23,687
Unit 6	Western Colorado	25,294

The SSA relied on both the available scientific literature and the professional judgments and opinions of recognized lynx experts to (1) describe the ecological requirements and population dynamics of the species, (2) evaluate the historic and current status lynx populations in the six geographic units and the factors that appear to have influenced these populations, and (3) assess the likely future viability of the DPS through the end of the century in terms of representation, redundancy, and resiliency (the "3 Rs").

Lynx are habitat and prey specialists and require boreal forests having long winters with deep, fluffy snow. These conditions provide lynx with a competitive advantage over other predators for exploiting their primary prey, the snowshoe hare. Lynx habitat and, thus, lynx are naturally less abundant and more patchily distributed in the DPS than in the core of the species' range in Canada and Alaska. This is because the DPS occurs at the southernmost margin of the

species' range and of the environmental thresholds of snow quality, depth, and persistence; hare density; and boreal forest conditions that lynx require. Maintaining connectivity between the DPS and lynx populations in Canada is thought to be important, but whether DPS populations rely on intermittent immigration of lynx from Canada, and if so to what extent, remain uncertain.

Research and surveys undertaken since the listing of the DPS in 2000 have significantly improved our knowledge of the distribution, habitats, and status of resident breeding lynx populations. For example, although we knew there were resident lynx in Maine, we did not have an understanding of population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS; we also understand that past timber management has created the current abundance of high-quality lynx habitat, and we believe that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain as to whether Minnesota supported a resident breeding population, but we now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. are naturally less abundant and more patchily distributed than was thought at the time of listing, and lynx may have been recently extirpated from several areas thought to have previously supported small resident populations (the Kettle Mountains in northeastern Washington, the Garnet Mountains in western Montana, and the Greater Yellowstone Area). We also know that recent extensive wildfires in north-central Washington have temporarily reduced the amount of high-quality lynx habitat and have probably caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999 to 2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado.

SSA Framework

The framework for conducting an SSA takes into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time. Relative to the ecological requirements of the lynx within the DPS, we assessed current conditions at the individual, population, and range-wide levels, and the likely changes in the environment that may influence the future condition of individuals, populations, and the DPS and thus the viability of the DPS.

The SSA uses the conservation biology principles of representation, redundancy, and resiliency (the "3 Rs") as the framework for assessing current and future conditions. Resiliency describes the ability of the species to withstand stochasticity, redundancy describes the ability of the species to withstand catastrophic events, and representation descr bes the ability of the species to adapt over time to long-term changes in the environment. The 3 Rs can be influenced by any number of factors. For the lynx, these factors included the original reason for listing the lynx DPS as threatened: inadequacy of regulatory mechanisms. Other factors included climate change, vegetation management, wildfires, and habitat connectivity

SSA Assumptions and Uncertainties

A fundamental hypothesis underlying the SSA is that the ability of lynx to persist in the DPS is a function of metapopulation dynamics with Canada, i.e., the DPS is infused intermittently with lynx from Canada following high hare cycles.

Overall, uncertainties abound with regard to lynx demography and effects of various stressors on DPS populations. The primary sources of uncertainty for this analysis include a lack of empirical data regarding population sizes and trends, the extent of immigration of lynx from Canada to the persistence of U. S. populations, trends in hare populations, and effects of habitat management on lynx. Most importantly given the importance of climate change as a stressor, we lack information on the pace and extent of changes in snow quality, depth, and persistence and how this affects the relationship between lynx and their competitors.

For purposes of the SSA, we forecasted potential effects and trends through the end of this century. This time frame is based on the level of uncertainty about climate change and other effects on lynx populations; it is also a long enough time frame to detect lynx population trends across the DPS.

Current Conditions

Currently, four of the six DPS units (Northern Maine, Minnesota, Northwestern Montana, and Western Colorado) demonstrate high levels of resiliency. North-central Washington (Unit 4) was also considered resilient until recent wildfires consumed an extensive amount of habitat, likely resulting in a diminished population that may be susceptible to stochastic events. The Greater Yellowstone area historically supported resident lynx, but it is unclear whether the area still supports a breeding population due to the distance and relative isolation of the unit from Canada as well as the less than favorable habitat conditions and snowshoe hare densities.

As shown in the table above, five of the six units are larger than 20,000 km^2; the other is over 5,000 km^2. Land ownership within the units varies from mostly private in Maine, to a mix of private, State, and federal lands in Minnesota, to mostly federal lands in the West. Overall, federal lands account for nearly 64 percent of the areas encompassed by the SSA units. Of non-federal areas, private lands make up almost 27 percent of the total followed by State and Tribal lands. Available data indicate that distribution within the DPS remains similar to historical patterns and that the number of units across the DPS has not been meaningfully diminished from historical levels, given the uncertainty about the past occupancy of the Greater Yellowstone area by a resident breeding lynx population.

Given the resiliency of most geographic units and the improbability that any imminent catastrophic event will cause the extirpation of an entire unit or, especially, the DPS as a whole, redundancy is not currently at issue for the lynx DPS. Also, because lynx are genetically similar throughout the entire range of the species, and because we did not find any diminishment of

adaptability and evolutionary capacity of DPS populations based on the known historical record, we do not consider representation to be a current issue for lynx.

The original reason for which the DPS was listed, inadequacy of regulatory mechanisms has been largely ameliorated on public lands within the western geographic units. Climate change, vegetation management, wildfires, and habitat fragmentation are now stressors of more heightened concern. We know that wildfires are causing depletion of lynx in some areas in the West, particularly in the North-Central Washington Unit. We also know that past vegetation management in the northern Maine Unit has resulted in a lynx population that is currently the largest in the DPS. Conversely, stressors such as climate change and associated habitat alterations, while currently occurring, may not demonstrate demographic effects on lynx within the next decade.

Future Conditions

Resiliency of individual geographic units, which function independently of each other, is the primary determinant of future lynx DPS viability. Overall, our analysis indicates a reduced probability of persistence for all geographic units within the DPS over the rest of the century (noting that the analysis did not extend beyond that 2100 time frame). It further indicates a consequent permanent loss of two to four of the six units, i.e., loss of resiliency, by the end of the century.

Representation and redundancy are lesser factors for DPS viability, for several reasons. Although the populations in the DPS units are demographically isolated from each other, there is little risk of significant genetic drift within the DPS, likely due to most areas being relatively well connected with Canadian populations; this is indicative of relative genetic health through the end of the century. Furthermore, based on expert input, there is no indication that the relatively low level of genetic diversity is likely to reduce DPS viability in the future (USFWS 2016, p. 51). Because of the ability of lynx to widely disperse, and because it is unlikely that insurmountable barriers to lynx dispersal between Canada and the DPS will emerge, we do not expect representation to become a concern through the turn of the century.

With regard to redundancy, neither the scientific literature nor expert input provide a basis for concluding that any catastrophic event could cause extirpation of any one geographic unit. It is even less like that a single catastrophic event will eliminate all populations in the DPS. It is important to note, however, that a sequence of events could extirpate individual units over time, thereby reducing redundancy within the DPS.

The likelihood of persistence of individual populations, and thus geographic units, is expected to decrease by 2100 primarily because of climate change effects on snow conditions and boreal forests. The other long-term threat is forest management practices that are not conducive to landscape hare densities able to support lynx, although this stressor may be limited to one geographic unit. Threats affecting the future condition of the DPS are summarized below.

Based on climate change models, the effects of climate change on snow and boreal forest conditions are foreseen as the primary stressor limiting future viability of lynx in the DPS. The southernmost boreal habitats are predicted to retreat northward and upslope, fragmenting and diminishing the quality of lynx and hare habitat within the DPS (although some uncertainty remains regarding the timing, extent, and biological consequences of such impacts). As habitat conditions decline, mortality rates are likely to increase and reproductive rates decrease. This in turn will reduce abundance and density of individuals within populations, making lynx populations more suscept ble to stochastic events.

Given the percent of federal land ownership, regulatory assurances that these lands will be managed in accordance with lynx conservation, and a stronger possibility that lynx populations will be able to relocate to higher elevations, western geographic units are more likely to support lynx longer under projected climate change scenarios. Nonetheless, we are unaware of any management action that can abate the long-term retreat of boreal forests and changed snow conditions. Further, climate-induced frequency and intensity of wildfires and disease events is expected to increase, particularly in the western portion of the DPS, although we do not anticipate such events in and of themselves to cause the permanent loss of breeding lynx populations in the Northwest or any other unit.

With regard to the eastern geographic units (Minnesota and Maine), suitable boreal forest and snow conditions are projected to decline more severely than in the western units. Lynx habitat conditions in Maine are also likely to decline significantly by the end of the century as private forest management practices, particularly a decline in clearcutting, result in succession detrimental to snowshoe hare and lynx needs.

DPS viability

Although there is no evidence from the historical record that Canada lynx have declined within the DPS, a number of threats acting at the DPS and individual geographic unit scales indicate a moderate to high likelihood of declines (i.e., loss of two to four units) by the turn of the century. While it is more likely than not that any given individual unit—northern Maine, northeastern Minnesota, northwestern Montana, western Colorado, and possibly north-central Washington—will persist to mid-century, it is unlikely all that five will persist to that point. By the end of the century, we expect populations to persist primarily in units having high-elevation refugia, e.g., northwestern Montana and possibly western Colorado, although Colorado would be an isolated unit. Lynx may also persist at the end of the century in Maine, depending on the severity of climate change effects and trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in concert with input from lynx experts indicates that all units will exhibit declines by 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the eventual loss of resiliency indicated by extirpation of geographic units will also reduce redundancy and, possibly, representation. These losses in resiliency, redundancy,

and representation will put the Canada lynx U.S. DPS at increasing risk of extinction over the course of this century, and in all probability, the risk will continue to increase after that point.

Chapter 1: Introduction

The U.S. Fish and Wildlife Service (Service) designated lynx in the contiguous U.S. as a distinct population segment (DPS) and listed it as threatened under the Endangered Species Act of 1973, as amended (ESA) in 2000 (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (U.S. District Court MT 2014b, p. 2). Thus, we conducted this SSA (version 1.0) to summarize the best available information on the current status and likely future viability of the DPS. This SSA will inform a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the ESA and (2) a recovery plan is needed to guide conservation and recovery of the lynx DPS.

1.1 Background

The Canada lynx is a North American wild cat that is most strongly associated with northern-latitude boreal forests (taiga) of Canada and Alaska (McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 373-374; Mowat *et al*. 2000, p. 272). It relies heavily on adequate populations of its primary prey, the snowshoe hare (*Lepus americanus*), to support survival, reproduction, recruitment, and, therefore, population persistence (Ruggiero *et al*. 2000a, p. 110; Mowat *et al*. 2000, p. 270; Steury and Murray 2004, pp. 128, 136-138; U.S. Fish and Wildlife Service 2005, p. 2; Interagency Lynx Biology Team [ILBT] 2013, pp. 30-34; 79 FR 54808-54809). Lynx survival and distribution is also influenced by snow conditions. It is generally restricted to areas that receive deep, powdery, and persistent snow that allows lynx, with their proportionately longer limbs and very large feet, to outcompete other terrestrial hare predators that are less efficient in such conditions (McCord and Cardoza 1982, pp. 748-749; Quinn and Parker 1987, p. 684; Buskirk *et al*. 2000a, pp. 89-94; Buskirk *et al*. 2000b, pp. 400-401; Ruggiero *et al*. 2000b, pp. 445–449; Hoving 2001, p. 75; Hoving *et al*. 2005, p. 744-749; Carroll 2007, entire; Gonzalez *et al*. 2007, entire; ILBT 2013, pp. 25-26; 79 FR 54809).

Lynx are generally considered secure, widespread, abundant, and distributed throughout most of their historic ranges in Canada and Alaska, which, combined, account for roughly 98 percent of the species' distribution. Lynx are distributed across approximately 5.5 million km^2 (2.1 million mi^2) in Canada (Environment Canada 2014, p. 2) and 534,454 km^2 (206,354 mi^2) in Alaska (University of Alaska Center for Science Conservation 2016, entire; Reimer 2016, pers. comm.). The southern peripheries of the boreal forest and the distributions of snowshoe hares and lynx extend into the northern contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 379-382; Hodges 2000, pp. 163-173; McKelvey *et al*. 2000a, pp. 242-253), where the six geographic units evaluated in this

SSA represent the remaining 2 percent of the species' breeding distribution (approximately 131,168 km^2 [50,644 mi^2]; see Figure 1 and Table 1, below). Lynx populations in the DPS seem to function as peripheral subpopulations (islands) of a larger (mainland) metapopulation centered in north-central Canada (McKelvey *et al*. 2000b, p. 25; 68 FR 40077; also see 2.2 below), and the demographic and genetic health and persistence of DPS populations are thought to be influenced by connectivity with, and immigration of lynx from, larger populations in Canada (McKelvey *et al.* 2000b, pp. 21, 33; Schwartz *et al.* 2002, entire; 78 FR 59434, 59447; 79 FR 54815).

Lynx were documented historically in 24 of the Lower 48 States (McKelvey *et al.* 2000a, pp. 207-232), but records in many places are associated with cyclic "irruptions" of large numbers of lynx dispersing from southern Canada when hare populations crashed; many of these occurrences were in anomalous habitats, and lynx were unable to persist and establish populations in most of these areas (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 242, 253; Aubry 2006, pp. 1-2; ILBT 2013, p. 23; see also section 2.3.2, below). Habitats capable of supporting persistent resident lynx populations in the contiguous U.S. occur over a much smaller geographic area that includes parts of the Northeast (primarily northern Maine), western Great Lakes (northeastern Minnesota), Rocky Mountains (northern Idaho, northwestern Montana; perhaps also parts of northeastern Washington, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming, and parts of western Colorado), and the eastern Cascade Mountains of northern Washington (68 FR 40077-40080; U.S. Fish and Wildlife Service 2005, p. 3; 79 FR 54806-54807; Lynx SSA Team 2016, pp. 6-7). Although uncertainty remains regarding the historic distribution of resident lynx in the contiguous U.S., and breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population decline in the contiguous U.S. has been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11; also see section 2.3.2, below).

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 14 states in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands (65 FR 16052). In 2003, in response to a court memorandum opinion on the 2000 listing rule, the Service reaffirmed its determination of the lynx DPS and its status as threatened under the ESA (68 FR 40076). The Service completed a recovery outline in 2005 (U.S. Fish and Wildlife Service 2005, entire), designated critical habitat for the DPS in 2006 (71 FR 66008) and, in 2007, again in response to a court order, clarified its determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS (72 FR 1186). Also in 2007, the Service initiated a 5-year status review of the DPS (72 FR 19549). The Service revised the critical habitat designation for the DPS in 2009 (74 FR 8616) and 2014 (79 FR 54782) and, concurrent with the latter, rescinded the state-based definition of the DPS boundary to formally extend ESA protection to lynx "where found" in the contiguous U.S., including New Mexico and other states that were not included in the original DPS range (79 FR 54804). The Service reinitiated the 5-year status review in 2015 (https://www.fws.gov/mountain - prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php), and that

review will be informed by this SSA report. On September 7, 2016, the U.S. District Court for the District of Montana remanded the 2014 critical habitat designation to the Service for further consideration.

The six geographic units evaluated in this SSA encompass all areas of the contiguous U.S. that currently support or are believed to have recently supported persistent resident lynx populations (Figure 1). Five of the six geographic units were designated as “Core Areas” in the Recovery Outline (USFWS 2005, pp. 4-6, 21, 23), and western Colorado was designated a “Provisional Core Area” (USFWS 2005, pp. 6, 21, 23). With the exception of western Colorado, these units also encompass and closely mirror the areas the Service designated as critical habitat in 2014 (79 FR 54782). Some areas adjacent to but outside these geographic units are known or suspected to intermittently support lynx home ranges and occasional reproduction. Uncertainty remains as to whether resident lynx populations occurred historically in other areas not encompassed by the geographic units evaluated here.

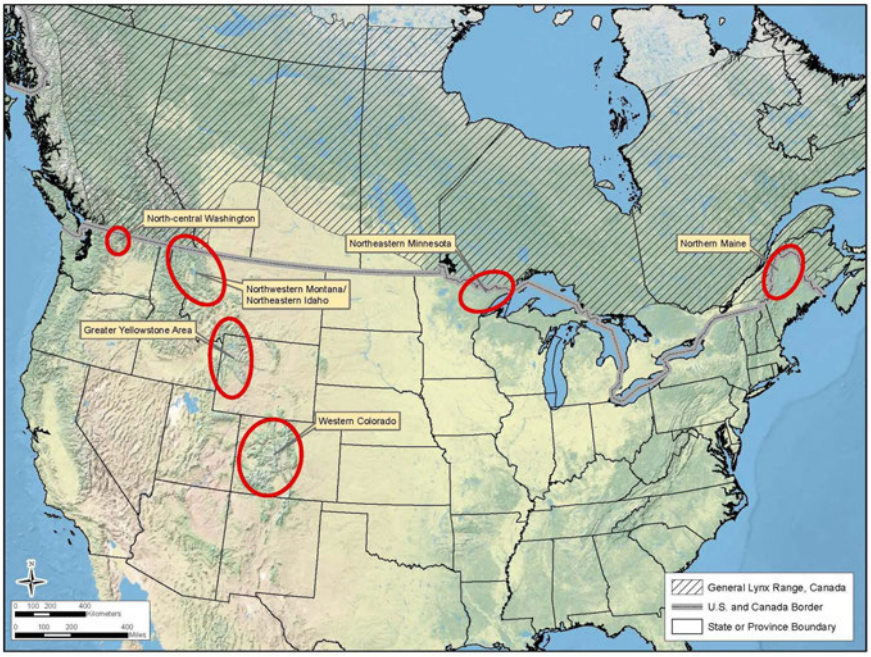


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*) that currently support or recently supported (GYA) resident lynx populations relative to the general range of lynx in Canada. Range in Canada based on Poole (2003), Koen *et al.* (2014), and Vashon (2015).

The six geographic units include federal, private, State, and Tribal lands. The amounts in each ownership vary among the units, with private lands predominating in Maine, a mix of ownerships in Minnesota, and federal lands predominating in the western units (Table 1).

Table 1. Lynx SSA Unit Sizes and Percent Ownership.

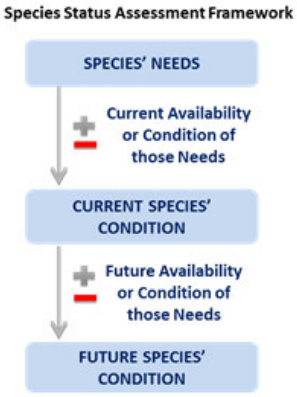
Unit[1]	Unit Size (km^2)	Percent of SSA Area	Land Ownership/Management (Percent)[2]						
			Federal				Private	State	Tribal
			All Federal	USFS	NPS	BLM			
1	28,909	22.0	0	0	0	0	91.6	7.3	0.9
2	21,101	16.1	47.4	44.9	2.5	0.01	15.5	36.2	1.0
3	26,997	20.6	84.3	69.3	13.6	1.5	8.0	4.1	3.5
4	5,176	3.9	91.5	84.6	6.7	0.1	0.3	8.2	0
5	23,687	18.1	97.6	79.7	16.7	1.1	2.2	0.3	0
6	25,294	19.3	90.1	85.2	1.8	3.1	9.3	0.6	0
All Units	131,164	100	63.6	55.6	6.8	1.1	26.5	8.8	1.1

[1] Unit 1 - Northern Maine; Unit 2 - Northeastern Minnesota, Unit 3 - Northwestern Montana/ Northeastern Idaho, Unit 4 - North-central Washington, Unit 5 - the Greater Yellowstone Area (southwestern Montana/Northwestern Wyoming), Unit 6 - Western Colorado.

[2] Unit sizes and ownership for units 1-5 are those calculated for the areas designated in 2014 as lynx critical habitat, including some Tribal, State and private lands that met the criteria for critical habitat but which were excluded from the designation in accordance with section 4(b)(2) of the Endangered Species Act. Unit 6 size and ownership were calculated by the Service's Western Colorado Field Office in coordination with Colorado Parks and Wildlife based on telemetry data from radio-marked lynx.

1.2 SSA Framework and Report

The Service is engaged in a number of efforts to improve the implementation of the ESA (see http://www.fws.gov/endangered/improving_ESA/). As part of this effort, our Endangered Species Program has developed the Species Status Assessment (SSA) Framework to guide how we assess the best scientific and commercial data available when evaluating the biological status of species. In conducting an SSA, we take into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time (captured under the broad heading of "species needs"); the current condition of the species at the individual, population, and range-wide levels in terms of meeting those needs; and the likely changes in the environment that may influence the species' future condition and, thus, the viability of the species.



The SSA Framework defines viability as a description of the ability of a species to sustain populations in the wild beyond a biologically meaningful time frame[1]. Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3 Rs") as a lens to evaluate the current and future condition of the species. Briefly, resiliency describes the ability of the species to withstand stochastic events; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. As a result, the SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distr bution within the species' ecological settings. Importantly, the SSA neither results in, nor predetermines, any decisions by the Service under the ESA.

The Species Status Assessment Report (SSA Report) is a summary of the information assembled, reviewed, and assessed by the Service and is based on the best scientific and commercial data available at the time of the assessment. Completed SSA Reports and supporting material can be found at the collaborative repository of the National Park Service and the USFWS called "ServCat" at the following IP address: *http://www.fws.gov/Refuges/NaturalResourcePC/landM/serviceCatalog.html*.

1.3 Analytical Approach/Methods

We used the SSA Framework (October 2015, version 3.3) described above to evaluate the current status of resident lynx in the contiguous U.S. as well as the likelihood that the geographic areas supporting resident lynx in the DPS would continue to do so in the near term and at mid- and end-of-century (years 2025, 2050, and 2100). We framed our evaluation in

[1] Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations in the wild over time. USFWS. 2015. Species Status Assessment Framework. Version 3.3. October 2015.

terms of the 3 Rs using conceptual modeling (Figure 2) based on available published literature, other information on the historic and current status of and threats to lynx in the DPS and, where empirical data are lacking, on formally-elicited expert opinion and best professional judgment (Lynx SSA Team 2016, entire).

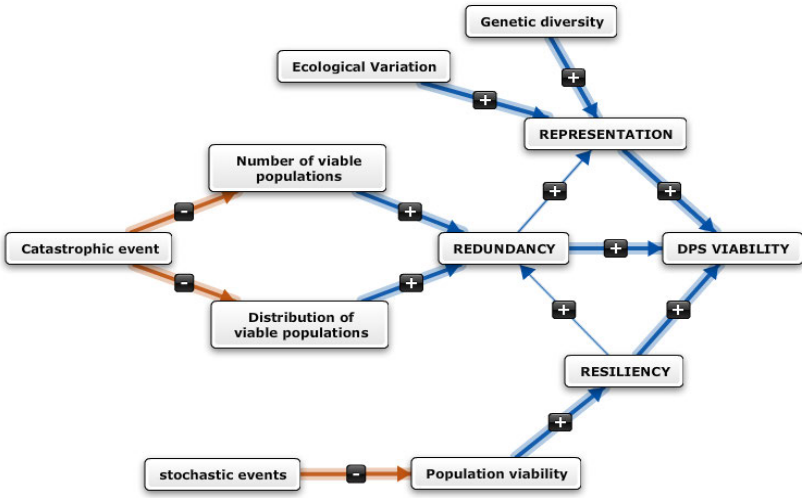


Figure 2. Conceptual model of the factors thought to influence the 3 Rs as they pertain to lynx viability.

We applied the definitions from the SSA Framework for the principles of redundancy, representation, and resiliency, provided in section 1.2, to Canada lynx as described below. We evaluated redundancy and representation at the scale of the DPS as a whole, and resiliency at the scale of lynx populations within each of the six geographic units.

To evaluate **redundancy** for the lynx DPS, we considered the current and likely future geographic distributions of resident breeding populations and whether the DPS is currently vulnerable to extirpation due to catastrophic event or would be in the future. Figure 3 shows examples of relationships among factors that may influence redundancy within the lynx DPS.

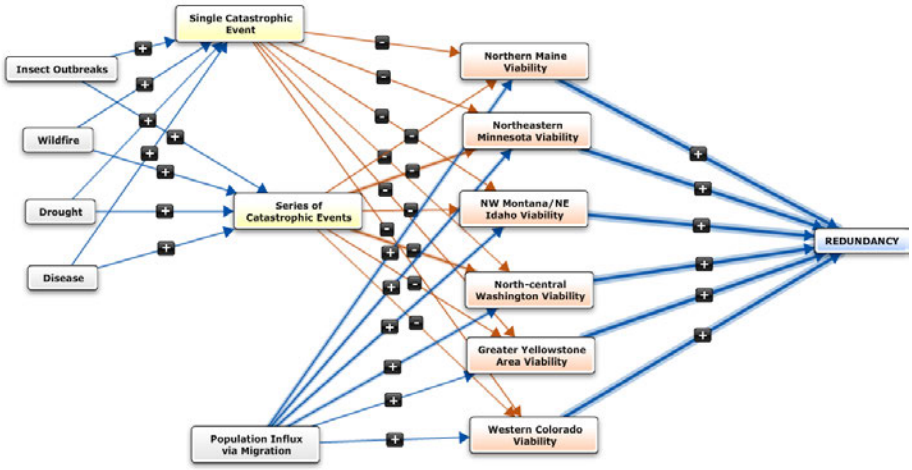


Figure 3. Conceptual model of factors thought to influence redundancy within the lynx DPS.

To evaluate **representation** for the lynx DPS, we considered measures of genetic diversity and heterozygosity, the current and likely future ecological diversity of geographic areas occupied by resident breeding populations, and the documented dispersal capabilities of the species, as shown in Figure 4 below.

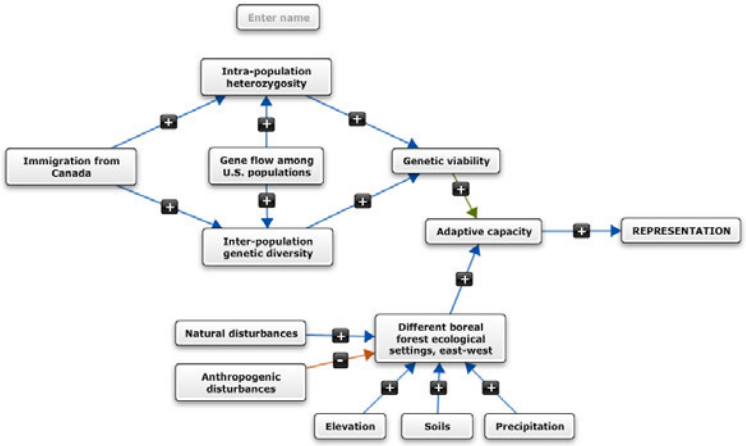


Figure 4. Conceptual model of factors thought to influence representation within the lynx DPS.

Because we lack reliable estimates of population sizes and trends, growth rates, and other long-term demographic data for most populations in the DPS, our evaluation of the **resiliency** of lynx

populations in the DPS was based largely on consideration of recent status updates and formally-elicited expert opinion regarding the likelihood that DPS populations will remain viable into the future. The relationships among factors that influence DPS resiliency are shown in Figure 5 below.

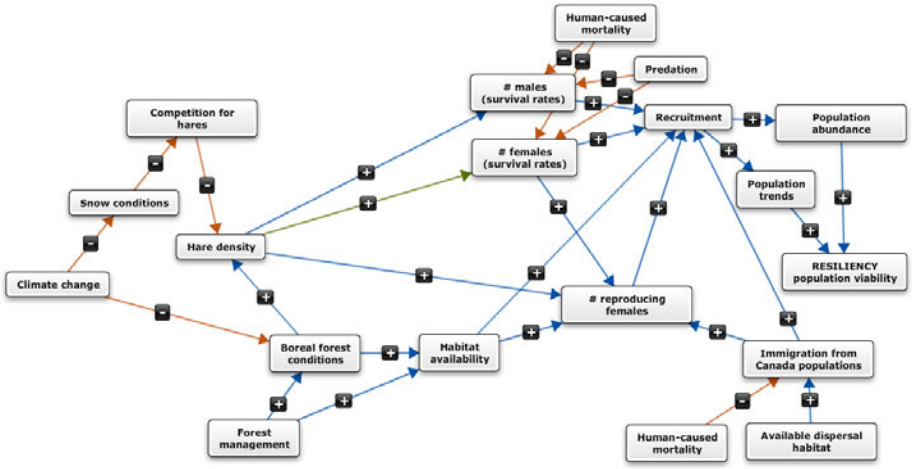


Figure 5. Conceptual model of factors thought to influence the resiliency of lynx populations within the DPS.

Chapter 2: Lynx Ecology

In this chapter, we describe the physical characteristics, taxonomy, and genetics of the Canada lynx, its life history and population dynamics, and its taxon-wide and DPS distributions. We rely heavily on recent summaries of this information provided in the revised *Canada Lynx Conservation Assessment and Strategy* (LCAS; ILBT 2013, entire), the Service's recent proposed (2013) and final (2014) rules to revise the designation of critical habitat for the DPS (78 FR 59430-59474; 79 FR 54782-54846), and the results of an October 2015 lynx expert elicitation workshop (Lynx SSA Team 2016, entire). We also provide a summary of the pertinent ecological requirements of lynx at the individual, population, and DPS levels. These ecological requirements form the basis of our analyses conducted in Chapters 3 through 5.

2.1 Species Taxonomy, Description, and Genetics

The Canada lynx (order Carnivora; family Felidae) is one of four species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). There are

three recognized subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. mollipilosus* ("Arctic lynx," Stone 1900), and *L. c. subsolanus* ("Newfoundland lynx," Bangs 1897) (Integrated Taxonomic Information System online database, http://www.itis.gov, retrieved April 14, 2016).

The Canada lynx is a medium-sized cat with long legs and large, well-furred paws. In winter, the lynx's fur is dense and has a grizzled appearance with a grayish-brown mix of buff or pale brown fur on the back, and a grayish-white or buff-white fur on the belly, legs, and feet. In summer, its fur is more reddish to gray-brown (McCord and Cardoza 1982, p. 730). It has long tufts of black hairs extending from the tips of its ears, a short, completely black-tipped tail, and often a distinct dish-like facial ruff of pale hairs tipped black. Lynx generally measure 75 to 90 cm (30 to 35 in) long and weigh 6 to 14 kg (14 to 31 lb) (Quinn and Parker 1987, Table 1; Moen *et al.* 2010a, Figure 2; Maine Department of Inland Fisheries and Wildlife 2012, unpublished data), and males are 13-25 percent larger than females (Mowat *et al.* 2000, p. 267). The lynx's large feet and long legs make it highly adapted for traversing and hunting in deep, powdery snow, where its low foot-loading (weight per surface area of foot) is thought to provide a competitive advantage (Buskirk *et al.* 2000a, p. 90; 2000b, p. 400; ILBT 2013, pp. 26, 36, 81) over other terrestrial predators of snowshoe hares, the lynx's primary prey. In southern Canada and the northern contiguous U.S, where the southern edge of the lynx range overlaps the northern edge of the bobcat range, the two species are easily confused because of their similar size and appearance. However, the lynx's longer ear-tufts, larger feet, and black-tipped tail distinguish it from the bobcat, which has shorter ear tufts, small feet, white on the underside of the tail, and is much more common and abundant than lynx in most of the contiguous U.S..

Overall, genetics research suggests high gene flow across most of the continental range of lynx, l kely because of high dispersal rates, large dispersal distances, and the absence of significant barriers to genetic interchange throughout much of the lynx range, including the DPS (Schwartz *in* Lynx SSA Team 2016, pp. 11-12). Genetic evidence also indicates interactions between lynx populations even where physical barriers appear most likely to restrict gene flow. For example, although *L. c. subsolanus* on Newfoundland Island is genetically (Row *et al.* 2012, pp. 1262-1266; Koen *et al.* 2015, p. 528) and morphologically (Khidas *et al.* 2013, pp. 597-601) distinct from mainland lynx, there is evidence of genetic exchange between the two areas, indicating that some lynx are able to cross the 15-60 km-wide (9-37 mi) Strait of Belle Isle that separates them (Koen *et al.* 2015, p. 527). Similarly, despite some differences in functional genetic markers (unique alleles) in lynx south versus north of the St. Lawrence Seaway/River in eastern Canada, which suggest the potential for evolutionarily significant differences in those areas, recent analyses reveal genetic exchange among lynx on either side, indicating that some lynx successfully navigate this barrier (Koen *et al.* 2015, pp. 524-528; Bowman *in* Lynx SSA Team 2016, p. 12-13).

Schwartz *et al.* (2003, entire) documented reduced genetic variation (lower mean number of alleles per population and lower expected heterozygosity) among peripheral lynx populations compared to populations in the core of the lynx geographical range in Canada and Alaska. While recognizing that small changes in genetic variation can lead to large changes in

population fitness, the authors noted that the differences between core and peripheral populations in their study were small enough to suggest a lack of significant population subdivision (i.e., no indication of genetic isolation, substantial genetic drift, or potential genetic ‘‘bottlenecks’’ among DPS populations; Schwartz *et al.* 2003, p. 1814; 79 FR 54793). This finding is consistent with their earlier work, which documented high levels of gene flow (the highest yet documented for any carnivore) between core and peripheral lynx populations despite large separation distances (Schwartz *et al.* 2002, entire). Their results did not suggest that reduced genetic variation among peripheral populations was because of human disturbance (i.e., habitat loss/ fragmentation on the southern periphery of the geographic range; Schwartz *et al.* 2003, p. 1814), but they did imply that the persistence of lynx populations in the contiguous U.S. depends on dispersal from larger (core) populations (Schwartz *et al.* 2002, p. 522). Currently, there is no indication that the levels of connectivity and gene flow between lynx populations in the DPS and those in the core of the lynx’s range are inadequate to maintain the genetic health of DPS populations. Given the connectivity of most DPS units with lynx populations and habitats in Canada, the noted dispersal capabilities of lynx, evidence of dispersal in both directions across the Canada-U.S. border (Aubry *et al.* 2000, pp. 386-387; Squires *et al.* 2006a, p. 38; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and the small number of immigrants thought necessary to maintain genetic variability in peripheral populations (McKelvey *et al.* 2000b, pp. 23-24), genetic isolation, biologically meaningful genetic drift, or potential genetic ‘‘bottlenecks’’ appear unlikely among most DPS populations in the future (79 FR 54793).

Within the contiguous U.S., minor genetic sub-structuring has been documented among lynx subpopulations in western Montana (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5). Additionally, lynx-bobcat hybridization has been documented in Minnesota, Maine and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where male bobcats bred with female lynx to produce fertile offspring with lynx-like ear tufts, intermediate foot-size, and bobcat-like fur (ILBT 2013, p. 35). In Minnesota from 2000 to 2015, DNA analyses documented 13 distinct hybrid individuals (Moen and Catton *in* Lynx SSA Team 2016, pp. 13, 19); no hybrids have been documented in the western portion of the lynx’s range (Schwartz *in* Lynx SSA Team 2016, p. 12).

2.2 Life History and Population Dynamics

All aspects of lynx life history are inextricably tied to its primary prey, the snowshoe hare (Figure 6). Snowshoe hares comprise a majority of the lynx diet throughout its range (Nellis *et al.* 1972, pp. 323–325; Brand *et al.* 1976, pp. 422–425; Koehler 1990, p. 848; Apps 2000, pp. 358–359, 363; Aubry *et al.* 2000, pp. 375–378; Mowat *et al.* 2000, pp. 267–268; von Kienast 2003, pp. 37–38; Squires *et al.* 2004a, p. 15, Table 8, Olson 2015, pp. 60-69), and hare abundance is the major driver of lynx population dynamics. Lynx den site selection, litter sizes, pregnancy, as well as recruitment, survival (kitten, subadult and adult) and dispersal rates, and population age structure, home range sizes, density, and distribution are all strongly influenced by hare abundance (Koehler and Aubry 1994, pp. 75-76, 80-83; Apps 2000, entire; Aubry *et al.* 2000, pp. 375-390; Mowat *et al.* 2000, pp. 270-294; ILBT 2013, pp. 18, 22-24, 26-34).

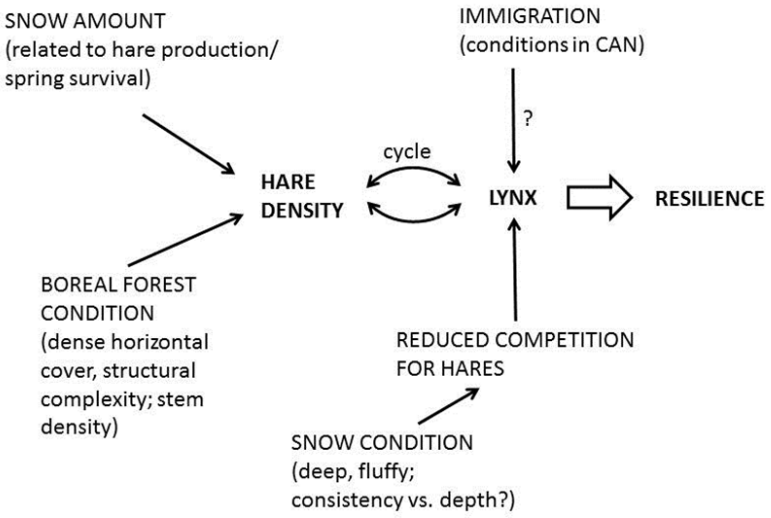


Figure 6. Generalized relationship between habitat conditions and hare and lynx population dynamics and their influence on lynx population resiliency.

Lynx are highly specialized predators of snowshoe hares and are dependent on landscapes with high-density snowshoe hare populations for survival and reproduction (McCord and Cardoza 1982, p. 744; Quinn and Parker 1987, pp. 684-685; Aubry *et al.* 2000, pp. 375-378). Lynx and snowshoe hares are strongly associated with what is broadly described as boreal forest (Bittner and Rongstad 1982, p. 154; McCord and Cardoza 1982, p. 743; Quinn and Parker 1987, p. 684; Agee 2000, p. 39; Aubry *et al.* 2000, pp. 378-382; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-191; McKelvey *et al.* 2000a, pp. 211-232). The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (*Picea* spp.) and fir (*Abies* spp.) (Elliot-Fisk 1988, pp. 34-35, 37-42). Snowshoe hares feed on conifers, deciduous trees, and shrubs (Hodges 2000b, pp. 181-183) and are most abundant in forests with dense understories that provide forage, cover to escape from predators, and protection during extreme weather (Wolfe *et al.* 1982, pp. 665-669; Litvaitis *et al.* 1985, pp. 869-872; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-195). Over much of the lynx's range, hare densities are higher in regenerating, earlier successional forest stages because they often have greater understory structure than mature forests (Buehler and Keith 1982, p. 24; Wolfe *et al.* 1982, pp. 665-669; Koehler 1990, pp. 847-848; Hodges 2000b, pp. 183-195; Homyack 2003, pp. 63, 141; Griffin

2004, pp. 84-88). However, snowshoe hares also can be abundant in mature forests with dense understories, particularly in the Northern Rocky Mountains (Griffin 2004, pp. 53-54; Griffin and Mills 2009, pp. 1492-1496; Hodges *et al.* 2009, p. 876; Squires *et al.* 2010, pp. 1653-1657; Berg *et al.* 2012, pp. 1483-1487). These mature forests may be a source of hares for other adjacent forest types (Griffin and Mills 2009, pp. 1492, 1495-1496), and they may provide especially important winter foraging habitats (Squires *et al.* 2010, pp. 1655-1657), which may be the most limiting habitat for lynx (Squires *et al.* 2010, pp. 1655-1657; ILBT 2013, pp. 17, 27). They also are more temporally-stable (i.e., they provide high-quality hare habitat for a longer period of time) than regenerating stands, which may foster high hare densities for a variable window of time between stand-initiation and stem-exclusion stages of succession, after which they may persist, in the absence of disturbance, for many years as lower-quality hare habitat (ILBT 2013, pp. 62, 71, 127).

Lynx habitat can generally be described as moist boreal forests that have cold, snowy winters and a snowshoe hare prey base (Quinn and Parker 1987, pp. 684-685; Agee 2000, pp. 39-47; Aubry *et al.* 2000, pp. 373-375; Buskirk *et al.* 2000b, pp. 397-405; Ruggiero *et al.* 2000b, pp. 445-447). Because lynx population dynamics, survival, and reproduction are closely tied to snowshoe hare availability, snowshoe hare habitat is the primary component of lynx habitat. However, lynx do not occur everywhere within the range of snowshoe hares in the contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729). This may be due to inadequate abundance, density, or spatial distribution of hares in some places, or the absence of snow conditions that would allow lynx to express a competitive advantage over other hare predators, or a combination of these factors (79 FR 54809).

The boreal forest landscape is naturally dynamic. Forest stands within the landscape change as they undergo succession after natural or human-caused disturbances such as fire, insect epidemics, wind, ice, disease, and forest management (Elliot-Fisk 1988, pp. 47-48; Agee 2000, pp. 47-69). As a result, lynx habitat within the boreal forest landscape is a shifting mosaic of habitat patches of variable and continually changing quality (68 FR 40077). These stands of differing ages and conditions provide lynx foraging or denning habitat (or may provide these in the future depending on patterns of disturbance and forest succession), and some serve as travel routes for lynx moving between foraging and denning habitats (McKelvey *et al.* 2000c, pp. 427-434; Hoving *et al.* 2004, pp. 290-292). Lynx generally concentrate hunting activities in areas where snowshoe hare densities are high (Koehler *et al.* 1979, p. 442; Ward and Krebs 1985, pp. 2821-2823; Murray *et al.* 1994, p. 1450; O'Donoghue *et al.* 1997, pp. 155, 159-160 and 1998, pp. 178-181; Fuller and Harrison 2010, entire; Simons-Legaard *et al.* 2013, pp. 573-575). Because understory density within a forest stand changes over time, hare habitat quality and corresponding hare densities also shift continually across boreal forest landscapes.

Hare populations in the core of the lynx range in Canada and Alaska undergo well-documented dramatic 8 to 11 year cycles during which hare numbers may fluctuate 10 to 25 fold or more, with peak densities as high as 23 hares/hectare (ha; 9.3 hares/acre [ac]) and lows of 0.1/ha (0.04/ac) (Hodges 2000a, pp. 117-121; Vashon 2015, p. 4). Hare densities are generally lower at the southern periphery of lynx distribution, and hare population cycles are generally much

less pronounced or absent entirely among some hare populations in southern Canada and in the contiguous U.S. (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17). In the contiguous U.S., stand-level hare densities may exceed 2 hares/ha (0.8 hares/ac) (Walker 2005, pp. 20, 85; McCann 2006, p. 15; Robinson 2006, pp. 26-36, 62-75; Homyack *et al.* 2007, pp. 10-11; Griffin and Mills 2009, p. 1492; Vashon *et al.* 2012, p. 14), but in many parts of the DPS, landscape-level densities are lower, ranging from just above to well below the 0.5 hares/ha (0.2/ac) density thought necessary to sustain lynx home ranges and populations (Hodges 2000b, pp. 168-169, 185; Ruggiero *et al.* 2000b, pp. 446–447; Squires and Ruggiero 2007, pp. 313-314; Maletzke *et al.* 2008, pp. 1476-1477; Zahratka and Shenk 2008, pp. 910-911; Hodges *et al.* 2009, pp. 873-877; Ivan 2011a, pp. 91-92, 95-102; Berg *et al.* 2012, p. 1483; ILBT 2013, pp. 24, 26, 90).

During lows in snowshoe hare populations, lynx prey opportunistically on other small mammals, especially red squirrels (*Tamiasciurus hudsonicus*), and birds, but alternate prey species do not sufficiently compensate for low availability of snowshoe hares, and lynx populations cannot persist over time in areas with consistently low hare densities (Brand *et al.* 1976, pp. 422–425; Brand and Keith 1979, pp. 833–834; Koehler 1990, pp. 848–849; Mowat *et al.* 2000, pp. 267–268). Nonetheless, even in areas with relatively low or marginal hare densities, hares constitute the majority of the biomass in lynx diets (Koehler and Aubry 1994, p. 85; Apps 2000, pp. 362-363; Aubry *et al.* 2000, pp. 375-378; Roth *et al.* 2007, pp. 2740-2741; Squires and Ruggiero 2007, pp. 310-313; Hanson and Moen 2008, p. 9; Maletzke *et al.* 2008, pp. 1475-1477; Shenk 2009, pp. 13, 16; Ivan *in* Lynx SSA Team 2016, Appendix 3, pp. 13-14).

Lynx typically mate in March and April, and kittens are born from late April to mid-June after a 60- to 70-day gestation period (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Female lynx typically reach reproductive maturity in their second year (at 22 months of age); however, when hares are abundant, females may breed at 10 months of age and produce kittens as 1-year-olds (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Males do not seem to breed as yearlings, and they do not contribute to rearing of young (ILBT 2013, p. 30). Lynx dens are typically located in areas of dense cover, where coarse woody debris, such as downed logs and windfalls, provides security and thermal cover for lynx kittens (McCord and Cardoza 1982, pp. 743-744; Koehler 1990, pp. 847-849; Slough 1999, p. 607; Squires and Laurion 2000, pp. 346-347; Organ *et al.* 2008, entire; Squires *et al.* 2008, pp. 1497, 1501-1505; Moen and Burdett 2009, entire). Dens have been documented in both mature and younger boreal forest stands (Mowat *et al.* 2000, pp. 274-275; Squires *et al.* 2008, p. 1497; ILBT 2013, pp. 29-30; 78 FR 59441-59442; 79 FR 54809-54810; Organ *et al.* 2008, entire), and the amount of structure (e.g., downed, large, woody debris, tip-up mounds) seems to be more important than the age of the forest stand for lynx denning habitat (Mowat *et al.* 2000, pp. 274-275, Organ *et al.* p. 1516). Denning habitat is not thought to be a limiting factor for lynx in the DPS (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517; Squires *et al.* 2008, p. 1505; ILBT 2013, p. 30; 79 FR 54790). Dens must be near foraging habitat to allow females to adequately provision dependent kittens, and females seem to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.*

2012, p. 16; ILBT 2013, p. 29). Females attend kittens at the natal den site and one or more alternate or maternal dens until kittens are about 6-10 weeks old (Squires *et al.* 2008, p. 1502; Vashon *et al.* 2012, p. 17; ILBT 2013, p. 29). Thereafter, kittens remain with their mothers through their first winter, apparently learning from her how to hunt and capture prey, initially on a small portion of her home range, but by fall on the larger area the female used before kittens were born (Mowat *et al.* 2000, pp. 269, 278). Juveniles remain closely associated with their mothers until February or March, when family groups begin to break up, with young typically dispersing in April and May (Mowat *et al.* 2000, pp. 278-279) to establish their own home ranges. Female offspring may establish home ranges overlapping or adjacent to their mother's home range and maintain mother-daughter bonds throughout their lives (Mowat *et al.* 2000, pp. 279-280). Male home ranges may slightly overlap adjacent male home ranges. While male home ranges typically overlap one to three female home ranges, and female home ranges are partially or completely encompassed by a male's home range, core areas within home ranges appear to be exclusive except during the breeding season (Koehler and Aubry 1994, pp. 90-91; Mowat *et al.* 2000, pp. 276-280; Vashon *et al.* 2012, pp. 17, 22-23). Fidelity to home ranges over several years has been documented for both sexes, but shifts and abandonment of home ranges have also been documented (Koehler and Aubry 1994, p. 91; Mowat *et al.* 2000, p. 277). Lynx have been documented to live up to 16 years in the wild (Kolbe and Squires 2006, entire).

Lynx populations in Canada fluctuate in response to the cycling of hare populations (Elton and Nicholson 1942, pp. 241–243; Hodges 2000a, pp. 118–123; Mowat *et al.* 2000, pp. 265–272), with synchronous fluctuations in lynx numbers emanating from the core of the Canadian population and spreading over vast areas, generally lagging hare numbers by one year (McKelvey *et al.* 2000a, pp. 232, 239; Mowat *et al.* 2000, pp. 266, 270). When hares are abundant, lynx have higher pregnancy rates and larger litter sizes, higher kitten survival, and lower adult mortality, resulting in rapid population growth during the increase phase of the hare cycle (Slough and Mowat 1996, pp. 955–956; Mowat *et al.* 2000, pp. 266, 270–272, 281–289). When hare populations are low, female lynx produce few or no kittens that survive to independence (Nellis *et al.* 1972, pp. 326–328; Brand *et al.* 1976, pp. 420, 427; Brand and Keith 1979, pp. 837–838, 847; Poole 1994, pp. 612–616; Slough and Mowat 1996, pp. 953–958; O'Donoghue *et al.* 1997, pp. 158–159; Aubry *et al.* 2000, pp. 388–389; Mowat *et al.* 2000, pp. 285–287). When hares decline, lynx mortality rates increase, largely because of starvation, and home range sizes and dispersal/ emigration rates also increase (Ward and Krebs 1985, pp. 2821–2823; O'Donoghue *et al.* 1997, pp. 156, 159; Poole 1997, pp. 499–503; Mowat *et al.* 2000, pp. 265–272, 278, 281–294). Lynx numbers decline dramatically during the ''crash'' phase of the hare cycle (Slough and Mowat 1996, p. 956; Mowat *et al.* 2000, pp. 283-285), when many lynx starve and many others abandon home ranges and disperse in search of food, with many of the latter also dying, often soon after initiating dispersal (Mowat *et al.* 2000, p. 293).

In Canada, lynx abundance may be 3 to 17 times higher at the peak versus the low of the hare cycle, with lynx densities reaching 30-45/100 km^2 (78-117/100 mi^2) in optimal dense regenerating forests 15-40 years post-fire, 8-20/100 km^2 (21-52/100 mi^2) in older forests or further south, and < 3/100 km^2 (< 8/100 mi^2) at the hare cycle low (Slough and Mowat 1996, pp.

952, 955; Mowat *et al.* 2000, p. 283; Hatler and Beal 2003, pp. 2, 5; Environment Canada 2014, p. 1). In southern Canada, where hares are less abundant and hare population cycles are muted or absent, lynx populations may be stable at 2-3/100 km^2 (5-8/100 mi^2) (Environment Canada 2014, p. 1). Lynx densities estimated in the contiguous U.S. have ranged from 9.2-13/100 km^2 (24-34/100 mi^2), including kittens, in Maine's highest-quality habitat when hares were abundant (Vashon *et al.* 2008, pp. 1483-1484; Vashon *et al.* 2012, pp. 14-15) to 2.3/100 km^2 (6/100 mi^2) in Washington when hare abundance was low (Koehler 1990, pp. 847-850). Correspondingly, hare abundance may also influence lynx home range size. Ward and Krebs (1985, pp. 2819-2820) documented a 3-fold increase in home range size in southwestern Yukon, from 13 km^2 (5 mi^2) on average when hares were abundant and increasing to 39 km^2 (15 mi2) when hare density was low. Poole (1994, pp. 613-614) documented a similar trend in the Northwest Territories, where lynx home range size increased from 17 km^2 (7 mi^2; males and females combined) when hares were abundant, to 44 km^2 (17 mi^2) and 62 km^2 (24 mi^2) for males and females, respectively, when hare numbers declined. In contrast, Breitenmoser *et al.* (1993, p. 552) reported no change in lynx home range size despite a 10-15 fold increase in lynx density as hare abundance increased in the southern Yukon. Similarly, in Maine, lynx home range size did not increase when hare densities declined from 2/ha (0.8/ac) to 1/ha (0.4/ac) (Mallett 2014, pp. 53-93). In general, hare and lynx densities are lower and lynx home ranges larger at the southern periphery of the lynx's range, including most of the contiguous U.S., and are similar to those of northern populations during the low phase of the hare population cycle (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367).

Lynx populations in the contiguous U.S. seem to function as subpopulations or southern extensions of larger populations in northern and eastern Canada (McKelvey *et al.* 2000b, pp. 21, 25, 33; 65 FR 16052–16082; 68 FR 40077–40099; 71 FR 66025–66035; 74 FR 8616–8641; Koen *et al.* 2015, pp. 527-528). Populations in the DPS are relatively isolated from one another, though most are directly connected via dispersal to lynx populations in Canada (McKelvey *et al.* 2000b, pp. 25-34; U.S Fish and Wildlife Service 2005, p. 2). Lynx disperse in both directions across the Canada–U.S. border (Aubry *et al.* 2000, pp. 386-387; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and this connectivity and interchange with lynx populations in Canada is thought to be important to the conservation of lynx populations in the DPS. (McKelvey *et al.* 2000b, p. 33; Schwartz *et al.* 2002, p. 522; U.S Fish and Wildlife Service 2005, p. 2; ILBT 2013, p. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187). However, whether and, if so, to what the extent the demographic and genetic health and persistence of populations in the DPS depend on regular or intermittent immigration of lynx from Canada remains uncertain (McKelvey *et al.* 2000a, pp. 241-242; 79 FR 54793).

2.2.1 Ecological Requirements of Individuals

At the most fundamental level, the needs of an individual lynx are met if:

1) it is born to a female that occupies a home range containing
    a) secure denning habitat,

b) adequate hare abundance to support lactation during the early kitten stage and later provisioning of the kitten with hare meat,
c) habitat (boreal forest and snow) conditions that reduce the likelihood and effect of competition from other hare predators, and
d) a low likelihood of encounters with lynx mortality agents (predators, trappers, vehicles, etc.);

2) the mother's home range occurs within a larger landscape that also contains adequate hare abundance and available habitat into which the yearling lynx may disperse and establish its own home range after the period of maternal dependence, with low likelihood of adverse competition and mortality; and

3) the larger landscape also supports other secure lynx home ranges and ensures the opportunity to encounter a lynx of the opposite sex, breed successfully, and contribute to the recruitment of at least one offspring into the breeding population during its lifetime.

In cyclic northern lynx populations, there is a strong element of timing that determines whether these individual needs will be met. During the decline and low phases of the hare population cycle, few kittens are born, very few survive until their first winter, and recruitment may collapse completely or nearly so for several successive years (Slough and Mowat 1996, entire; Mowat *et al*. 2000, pp. 266, 285-287). Therefore, even in the core of the species' range, a kitten born during a period of declining or low hare abundance is very unlikely to survive to independence, breed successfully, and replace itself within the breeding population in its lifetime. Conversely, a kitten born during the increase or high phase of the hare population cycle is much more l kely to survive, establish a home range, breed successfully, and replace itself via recruitment of one or more of its offspring into the breeding population.

In southern lynx populations (southern Canada and the contiguous U.S.), hare population cycles are of lower amplitude or absent (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17), and hare and lynx abundances and lynx demographic rates are typically like those of northern populations during hare lows (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367). Therefore, the likelihood that an individual lynx will have its ecological requirements met sufficiently so that it may replace itself in the breeding population is probably consistently relatively low, perhaps similar to lynx born during hare declines/lows in the north. Also in the south, there are more diverse assemblages of potential competitors and predators, more natural patchiness and anthropogenic fragmentation of lynx habitat (fewer areas with adequate hare densities and favorable snow conditions distributed broadly across large landscapes), and higher road densities and, thus, greater potential for lynx-vehicle collisions (Wolff 1980, p. 128; Buskirk *et al*. 2000a, entire). These factors probably further reduce the l kelihood that an individual lynx in the southern periphery of the range will survive, reproduce successfully, and have one or more offspring recruited into the resident breeding population.

Individual lynx require large areas of boreal forest landscapes to support their home ranges, provide hares in adequate abundance to meet their nutritional needs, provide breeding opportunities, and facilitate dispersal and exploratory travel. Female home ranges must also provide secure denning habitat in close proximity to foraging areas with high hare densities to allow females to adequately provision dependent kittens, and females appear to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). The size of lynx home ranges is strongly influenced by the quality of the habitat, particularly the abundance of snowshoe hares, in addition to other factors such as gender, age, season, and density of the lynx population (Aubry *et al.* 2000, pp. 382–385; Mowat *et al.* 2000, pp. 276–280). Generally, females with kittens have the smallest home ranges, l kely related to their need to stay close to dens and dependent kittens, and males have the largest home ranges (Moen *et al.* 2005, p. 11; Burdett *et al.* 2007, p. 463; ILBT 2013, p. 24).

The increased natural patchiness and fragmentation of high-quality hare habitat where boreal forest conditions transition to temperate forest types require individual lynx in many parts of the DPS to maintain relatively large home ranges that include patches of higher hare densities within a matrix of lower-quality habitats with lower hare densities (ILBT 2013, p. 126; 78 FR 59434; also see 2.3.3, below). Larger home ranges l kely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range (78 FR 59438). Annual home range sizes reported for lynx in the contiguous U.S. (Table 2, below) vary greatly across the DPS but are generally larger in the west than the east; however, differences should be interpreted with caution because different methods, sample sizes, and estimators were used to generate them (ILBT 2013, pp. 23-24).

Table 2. Reported annual home range sizes for Canada lynx in the contiguous United States.

Geographic Unit	Reported Lynx Home Range Size km^2 (mi^2)		References (pages)
	Female	Male	
N Maine	26 (10)	54 (21)	Vashon *et al.* 2012 (16-17)
NE Minnesota	17-21 (7-8)	160-267 (62-103)	Burdett *et al.* 2007 (460-463); Moen *et al.* 2008a (17)
NW Montana/ NE Idaho	43-115 (17-44)	122-238 (47-91)	Brainerd 1985 (20); Squires and Laurion 2000 (344); Squires *et al.* 2004a (13)
N-C Washington	37-91 (14-35)	49-69 (19-27)	Brittell *et al.* 1989 *in* Stinson 2001 (5); Koehler 1990 (847); Maletzke *in* Lynx SSA Team 2016 (21)
GYA	50 (19)	824 (318)	Squires *et al.* 2003 (12-13)

Commented [1]: Some of these home ranges seem to be presented as a range of values and others (e.g., ME, GYA) are a single value (a mean?). We should be consistent and present a mean and range, if these data are available.

W Colorado	75-704 (29-272)	103-387 (40-149)	Shenk 2008 (10)

Juvenile and adult lynx require about 400 and 600 grams (14 and 21 ounces) of food per day (for adults, 0.4-0.5 hares/day, 170-200 hares/year), respectively, to meet their basic nutritional requirements (Saunders 1963, p. 390; Nellis *et al.* 1972, pp. 324-325). Available research suggests that landscape-level hare densities >= 0.5 hares/ha (0.2/ac) are necessary to support lynx home ranges and resident breeding populations; lynx home range abandonment, dispersal, and mortality increase when hare densities are lower; and lynx may be unable to survive where landscape hare densities are below 0.3/ha (0.12/ac) (Ward and Krebs 1985, pp. 2819-2822; Slough and Mowat 1996, entire; Ruggiero *et al.* 2000b, pp. 446-447; ILBT 2013, pp. 26, 125). Recent research in the contiguous U.S. supports this - in northern Maine, areas with landscape hare densities of 0.74/ha (0.30/ac) supported resident breeding lynx, but areas with hare densities below 0.5/ha (0.2/ac) were not occupied by lynx (Simons-Legaard *et al.* 2013, pp. 567, 574-575). Likewise, in northeastern Minnesota, resident lynx maintained home ranges where landscape hare densities were 0.64/ha (0.26/ac). Voyageurs National Park, where hare density was estimated at 0.35/ha (0.14/ac), did not support resident breeding lynx (Moen *et al.* 2012, pp. 352–354).

In addition to adequate hare density, individual lynx require landscapes in which they are unlikely to encounter predators (mountain lion [*Puma concolor*], coyote [*Canis latrans*], wolverine [*Gulo gulo*], gray wolf [*Canis lupus*], fisher [*Pekania pennanti*], and other lynx) (ILBT 2013, pp. 33, 35). Although lynx have co-evolved with predators, the influence of predation on lynx populations is unknown (ILBT 2013, pp. 35-36), and mountain lions and coyotes are now more widespread and abundant in the southern periphery of the lynx distribution than they seem to have been historically (Buskirk *et al.* 2000a, p. 83; Gompper 2002, entire). Lynx also need landscapes where they are unlikely to suffer reduced fitness because of competition with other hare predators, or encounter traps or other anthropogenic causes of mortality. Except for fisher and marten (*Martes americana*), lynx predators and potential terrestrial competitors for hares (the species above plus bobcat; maybe red fox [*Vulpes vulpes*] in some situations) all have higher foot-loading (weight per surface area of the foot), making them less efficient at traveling and hunting in the deep powdery snow conditions favorable for lynx (Buskirk *et al.* 2000a, pp 86-95, Krohn *et al.* 2005, entire) and, therefore, likely limiting, at least seasonally, interactions between lynx and these species. Analysis of lynx occurrence data in the contiguous U.S. suggests that lynx require at least four months (December through March) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Where snow conditions do not consistently favor lynx, increased potential for predation and competition would be expected (Peers *et al.* 2013, p. 8). Finally, individual lynx are more likely to survive, breed, and replace themselves in the breeding population if they occupy home ranges where trapping is prohibited or trapping pressure is low (Slough and Mowat 1996, entire), high-speed/ high-volume roadways are absent (ILBT 2013, pp. 77-78), and other potential anthropogenic causes of lynx mortality are minimal.

In summary, individual lynx require large landscapes with hare densities that maximize their chances of (1) surviving to independence, (2) establishing and maintaining a home range, (3) breeding successfully, and (4) contributing genes to future generations (Breitenmoser *et al.*

1993, p. 552). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. The available science suggests that landscape-level hare densities consistently >= 0.5 hares/ha (0.2/ac) and favorable snow depth and conditions for about 4 months are needed to support lynx occupancy, reproduction, and recruitment. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or to do so inconsistently.

2.2.2 Ecological Requirements of Populations and the DPS

Lynx populations require essentially the same things that individual lynx do (see Figure 5 and section 2.2.1, above), but on a larger landscape with hare densities and habitat conditions capable of consistently supporting multiple home ranges, breeding and dispersal opportunities, and reproductive and survival rates such that recruitment and immigration will, on average over the long term, equal or exceed mortality and emigration (Pulliam 1988, pp. 652-654). To support persistent lynx populations, such landscapes must provide for the survival of at least some resident lynx even when hares are least abundant and/or other habitat features (e.g., snow conditions) are least favorable so that the population can recover, perhaps aided by immigration, when hare numbers and/or other habitat conditions recover or improve. As with individual lynx, populations are more likely to persist in landscapes where the effects of competition, predation, and human-caused mortality (e.g., trapping, vehicle collisions) are relatively lower.

In a mainland-island metapopulation structure l ke that thought to govern lynx population dynamics, the persistence of peripheral island populations is determined by colonization and extinction rates (McKelvey *et al.* 2000b, p. 25). Colonization is driven by the number of islands, the distances between them, and the species' dispersal capabilities and timing. Extinction rates are determined by population size and demographic and environmental stochasticity, with extinction more likely in smaller and more isolated populations (McKelvey *et al.* 2000b, pp. 25-31). Lynx populations in the DPS are at the periphery of the species' range and may behave as islands in a mainland-island metapopulation construct. In such a system, larger islands with higher habitat quality and in closer proximity to the mainland would be more likely to support persistent resident populations and to sometimes act as "sources" that produce surplus animals that may disperse to other islands. Smaller islands with lower habitat quality or at greater distance from the mainland may, in contrast, act as "sinks" that depend on immigration from source populations (McKelvey *et al.* 2000b, p. 30), and which may support resident lynx only occasionally, intermittently, or temporarily.

Formal population viability analyses (PVAs) have not been published for lynx populations in the DPS and may not be possible given limited data and natural temporal variation in demographic rates (McKelvey *et al.* 2000a, pp. 22, 30). Although some demographic data are available for most lynx populations in the DPS, most are limited to relatively few, small study areas or relatively short durations. There remains uncertainty about whether, and if so to what extent, the demographic health of DPS populations relies on immigration from northern (Canadian)

populations; and immigration rates are not known for DPS populations (McKelvey *et al.* 2000a, pp. 24-34). These factors likely preclude development of meaningful DPS-wide or unit-specific empirical population viability models (McKelvey *et al.* 2000b, p. 22).

Slough and Mowat (1996, p. 952, Table 4) calculated population growth rate (lambda, λ) = 2.03 (annual doubling) during the 4-year increase-to-peak phase for a lynx population in the core of the species' range in southern Yukon. This period of rapid growth was followed by a rate of λ = 1.01 (stable) during the first year of a hare decline, and λ = 0.10 and λ = 0.46 (rapid decline) during the first two years of the lynx population decline when hares were scarce. (Note – the value λ = 0.01 presented in Slough and Mowat (1996, p. 952, Table 4) appears to be an error; the correct value for λ in a population in which the estimated number of individuals declined from 135 in 1992 to 13 in 1993 should be 13/135 = 0.10 [as presented above]). However, the natural range in λ that would be expected among peripheral, isolated, or semi-isolated lynx populations where hares are non-cyclic or weakly-cyclic (i.e., in DPS populations), versus those that would signal long-term population decline or instability is unknown. Despite this, and the limitations noted above, Squires (*unpubl. data in* Lynx SSA Team 2016, p. 20) calculated population growth rates in northwestern Montana of λ = 0.92 for lynx in the Seeley Lake area (i.e., declining population trend, 1999-2007) and λ = 1.16 for lynx in the Purcell Mountains (increasing trend, 2003-2007). Likewise, McCollough (2016 *unpubl. data*; USFWS, Vortex10, deterministic population simulation) used demographic data from Vashon *et al.* 2012 (pp. 17-21) to calculate finite growth rates during a period of high hare density (λ = 1.16; increasing trend) and during a period of low hare density (λ = 0.88; decreasing trend) for the lynx population in northern Maine (see also section 4.1.1, below).

Although minimum viable population sizes have not been derived for lynx populations in the DPS, the Service's Recovery Outline (USFWS 2005, p. 5) suggested landscapes of at least 1,250 km^2 (483 mi^2) with sufficient boreal/subalpine habitat, hare densities (at least 0.5 hares/ha [0.2/ac]), and snow conditions favorable for lynx ("fluffy and/or deep...for sufficient periods to favor the competitive advantage of lynx"). These are the minimum landscape size and habitat conditions thought necessary to support a minimum lynx population of at least 25 adults based on a lynx density of one lynx per 50 square kilometers (USFWS 2005, p. 5). McKelvey *et al.* (2000b, p. 29) noted that extinction (extirpation) risk should decrease with increasing population size, and that extinction resulting from demographic stochasticity is very unlikely even for a population (generally; not specific to lynx) with as few as 20 reproducing females. Kramer-Schadt *et al.* (2005, entire) developed a spatially explicit population model for Eurasian lynx in Germany which they combined with demographic scenarios to evaluate the likely success of potential reintroduction efforts; they concluded that at least 10 females and 5 males would be required to establish a population with an extinction probability less than 5 percent over 50 years. Rodriguez and Delibes (2003, entire) evaluated extinction among populations of Iberian lynx; they found that extinction occurred only in small populations that occupied habitats of less than 500 km^2 and that extinction within 35 years was unlikely among populations occupying areas of at least 500 km^2 of adequate habitat quality.

In summary, lynx populations need large boreal forest landscapes with snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. These landscapes must have hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term. Immigration may be particularly important to the persistence and stability of lynx populations at the southern periphery of the range, including those within the DPS, where hare densities are generally low and hare populations are either non-cyclic or weakly-cyclic compared to northern populations. Low hare densities reduce the likelihood that lynx recruitment will consistently equal or exceed mortality, and non-cyclic or weakly-cyclic hare populations are unlikely to allow the rapid lynx population recovery observed in northern lynx populations when hare numbers increase dramatically after cyclic population crashes. Although immigration rates for DPS populations are unknown, as is the rate and periodicity of immigration needed to provide demographic stability among them, connectivity with and immigration from lynx populations in Canada is believed to be important to the persistence of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789).

2.3 Historic and Current Lynx Distribution

2.3.1 Lynx Distribution and Status in Canada and Alaska

The Canada lynx is broadly distributed across northern North America from eastern Canada to Alaska (McCord and Cardoza 1982, p. 729; Poole 2003, p. 361; Vashon 2015, p. 4; Alaska Center for Conservation Science 2016, p. 1). It is strongly associated with the expansive, continuous boreal forests of those areas, and its range largely overlaps that of its primary prey, the snowshoe hare, also a boreal forest specialist (Bittner and Rongstad 1982, p. 146; Mowat *et al.* 2000, pp. 268-269; Aubry *et al.* 2000, p. 375). In Canada, lynx are thought to occupy about 5.5 million km^2 (over 2.1 million mi^2), which represents 95 percent of their historic range in that country (Environment Canada 2014, p. 2), and over 89 percent of the species' entire distribution. Nationally in Canada, lynx are classified as secure, widespread, and abundant; they are managed for long-term population stability, with a conservative estimate of 110,000 individuals during cyclic lows; and no acute, widespread threats to lynx have been identified (Environment Canada 2014, entire; Vashon 2015, pp. 1-6). Provincially, lynx status is considered secure in British Columbia, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Northwest Territories, and the Yukon; sensitive in Alberta and Saskatchewan; at risk/endangered in New Brunswick and Nova Scotia; and undetermined in Nunavut (Environment Canada 2014, pp. 3-4; Vashon 2015, p. 1). Lynx were extirpated from Prince Edward Island (0.1 percent of lynx range in Canada) by the late 1800s, and on the mainland the southern margin of assumed lynx range has contracted northward in Quebec, southeastern

Ontario, Manitoba, Saskatchewan, and Alberta (Poole 2003, p. 361; Bayne *et al.* 2008, pp. 1192-1195; Koen *et al.* 2014, pp. 757-760).

In Alaska, lynx are distributed across roughly 534,454 km^2 (206,354 mi^2) of boreal forest habitats (University of Alaska Center for Science Conservation, http://akgap.uaa.alaska.edu/species-data/canadian-lynx-annual-distribution/#content, accessed 4/28/2016; Reimer 2016, pers. comm.), which represents about 8.7 percent of the species' distribution. Lynx in Alaska are apparently secure, with low to moderate threats, and populations appear stable statewide, although total abundance is unknown (Alaska Natural Heritage Program 2008, pp. 2-4). In both Alaska and Canada, lynx trapping is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Alaska Natural Heritage Program 2008, pp. 2-6; Vashon 2015, pp. 5-6). Along the Canada-U.S. border in provinces adjacent to DPS lynx populations, lynx trapping is prohibited in New Brunswick (adjacent to northeastern Maine) but regulated trapping is permitted in Quebec (adjacent to northwestern Maine, northern New Hampshire, and northern Vermont), Ontario (adjacent to northeastern Minnesota), Alberta (adjacent to northwestern Montana), and British Columbia (adjacent to northwestern Montana, northern Idaho, and northern Washington).

2.3.2 Lynx Distribution in the Contiguous United States

2.3.2.1 Defining Lynx Distribution at the Periphery of the Range

Several aspects of lynx population dynamics and dispersal patterns have resulted in inconsistent approaches and difficulty in defining the range and/or distribution of the species, especially at the margins (74 FR 66942). These, combined with uncertainty and ambiguity in the historical record of lynx occurrence, with early assessments based largely on trapping harvest records of questionable accuracy, particularly where lynx and bobcats overlap, and a reliance on anecdotal or unverified occurrence information (McKelvey *et al.* 2000a, pp. 208-210; 65 FR 16054), confound efforts to accurately portray the species' historical distr bution in the contiguous U.S. and to assess the current distribution relative to historic conditions (79 FR 54814-54815; McKelvey *in* Lynx SSA Team 2016, p.11). They also have resulted in inaccurate portrayals of lynx distribution and misperceptions that the historic range of lynx in the contiguous U.S. was once much more extensive than is ecologically possible (68 FR 40080; 74 FR 66942).

The range of the lynx must be considered differently from those of other species that are less mobile and have more stable population dynamics. Because the lynx is highly mobile and has cyclic population dynamics that are tied to cyclic snowshoe hare populations, numbers of lynx naturally fluctuate and become extremely low at times during a cycle. Additionally, where snowshoe hare populations are not adequate, resident lynx populations cannot be sustained. Because of this, resident lynx populations never occurred everywhere boreal forest existed in the contiguous U.S. Where the boreal forest was naturally more patchy and marginal, the habitat was incapable of supporting an adequate snowshoe hare population that in turn was incapable of supporting a resident lynx population over time. As a result, only a few areas in the

contiguous U.S. historically supported an adequate quantity and quality of habitat to support resident lynx populations over time, and many historical lynx occurrences across a large area of the contiguous U.S. were likely dispersers. The occurrence of dispersing lynx is unpredictable, and dispersing lynx will likely continue to periodically move into areas that are not lynx habitat (68 FR 40077).

The dramatic, cyclic fluctuations in lynx populations across much of the range as they track cyclic hare populations and the mass synchronous dispersals (irruptions) of large numbers of lynx into the contiguous U.S. when northern hare populations crashed are well-documented (Elton and Nicholson 1942, entire; Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 219, 232-242; Mowat *et al.* 2000, pp. 281-294; ILBT 2013, p. 33). These events have resulted in records of lynx occurrence, in some cases very rarely, in others sometimes in large numbers and with intermittent (cyclic) regularity, in places that otherwise lack evidence of persistent lynx presence or the habitats and hare densities necessary to support a resident lynx population (U.S. Fish and Wildlife Service 2005, pp. 3-4; 79 FR 54787-54789, 54793-54795, 54812-54823). Many records of lynx in the contiguous U.S. appear to be related to such events, including the unprecedented ‘‘explosions’’ of lynx observed in the early 1960s and 1970s (Gunderson 1978, entire; McKelvey *et al.* 2000a, pp. 232-242). During these events, many lynx occurred in anomalous habitats, exh bited unusual behavior, suffered high mortality, and numbers declined dramatically within a few years of irruptive peaks (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, p. 242). Because dispersing lynx typically do not persist in these areas of temporary range expansion, disappearing fairly quickly after irruptions, van Zyll de Jong (1971, p. 16), suggested that only areas that support lynx populations throughout both the low and the high phases of the “10-year cycle” (i.e., across the natural range of hare densities) should be considered to constitute the species’ range. In its 2003 remanded determination, the Service determined that lynx in the contiguous U.S.exist either as resident populations or as dispersers, that dispersing lynx are often found repeatedly and for variable amounts of time in habitats that cannot sustain breeding populations over time (though some breeding may occur occasionally in some of these areas), and that such areas probably contribute little to the persistence of lynx in the DPS (68 FR 40077, 40079-80). This repeated dispersal into habitats that ultimately cannot support the species (‘‘sink’’ habitats) often leads to confusion among scientists and the public about where lynx populations may be viable (74 FR 66938).

In addition to distinguishing between historical occurrence records associated with irruptions/ dispersal and those suggesting resident lynx populations, the “mainland-island” metapopulation structure thought to govern lynx populations in the DPS (McKelvey *et al.* 2000b, pp. 25-31; see Section 2.2, above) and the transitional (and, therefore, increasingly fragmented and isolated) and spatially- and temporally-shifting nature of lynx habitat at the southern periphery of the range (Koehler and Aubry 1994, pp. 78-79; McKelvey *et al.* 2000b, pp. 29-30; 74 FR 66940; 79 FR 54814) also present challenges in defining the distribution of lynx. Both factors suggest that some areas of the contiguous U.S. may naturally support resident lynx only temporarily or occasionally when habitat conditions (both boreal forest vegetation supporting abundant hares and snow conditions favoring lynx) are adequate and/or when immigration is sufficient to offset

the lower productivity and recruitment rates expected among lynx populations in marginal or suboptimal habitats. McKelvey *et al.* (2000b, pp. 21, 29-31) described such habitats as "... source-sink mosaics that shift with disturbance and succession," and the contribution, if any, of these places (especially those that act more often as "sinks" than "sources") to the maintenance and persistence of lynx populations in the DPS remains questionable (74 FR 66938).

Finally, the southern periphery of the lynx's range, where lynx are rare in many places, overlaps with the northern distribution of the much more common bobcat; the two species are difficult to distinguish in the field, they often were not reliably differentiated in historical trapping records (McKelvey *et al.* 2000a, pp. 208-209), and errors in early accounts of lynx distribution based on anecdotal information seem likely (Halfpenny and Miller 1980, pp. 1, 3-8; Meaney 2002, pp. 3-5, Hoving *et al.* 2003, pp. 366-367; Krohn 2010, p. 33). Because of the large effect that relatively few errors in identification can have on assessments of the distribution of rare animals, especially those that are easily confused with a similar and more common species, McKelvey *et al.* (2000a, p. 209; 2008, pp. 553-554) suggest that anecdotal information should be interpreted with caution, and only verified occurrence data should be used to assess historical and current lynx distributions.

These complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with a naturally dynamic and transitional habitat, make it difficult, if not impossible, to precisely delineate the historic or current distribution of resident lynx populations in the contiguous U.S. (Koehler and Aubry 1994, p. 79; 68 FR 40084). While recognizing these limitations, we use our best professional judgment of the best scientific and commercial data available to make conclusions about the range of the lynx for the purposes of this SSA. In the following section, we descr be the types and distributions of potential lynx habitats in the contiguous U.S., and our current understanding of the historical and current distributions of resident lynx populations in the DPS considering the factors discussed above.

2.3.2.2 Lynx Distribution within the DPS Range

The southern periphery of boreal forest vegetation extends into parts of the northern contiguous U.S., where it transitions to the Acadian forest in the Northeast (Seymour and Hunter 1992, pp. 1, 3), deciduous temperate forest in the Great Lakes regions, and subalpine forest in the Rocky Mountains and Cascade Mountains in the west (Agee 2000, pp. 40-41). In much of the DPS range, these boreal forest landscapes become naturally patchy and transitional because they are at the southern edge of the boreal forest range, and they are limited, particularly in the west, by elevation and/or aspect (Ruediger *et al.* 2000, p. 4-16; 68 FR 40090). There also is increased prevalence of non-forested land uses (e.g., agriculture, development) at the southern periphery of boreal forests. These factors generally limit snowshoe hare populations in the contiguous U.S. from achieving landscape densities similar to those of the expansive northern boreal forest in Alaska and Canada, where hares are generally more abundant and more evenly distr buted across the landscape (Wolff 1980, pp. 123-128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373-375, 382, 394). Consequently, important foraging habitat for lynx is often more limited and fragmented in the

contiguous U.S. than in boreal forests of northern Canada and Alaska (Berg and Inman 2010, p. 6), and overall habitat quality is typically lower.

The habitats that lynx use in the contiguous U.S. are characterized by patchily-distr buted moist forest types with relatively higher hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with lower landscape hare densities (ILBT 2013, p.126; 78 FR 59434). In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support higher hare densities where most lynx foraging occurs. In some areas, patches of habitat containing snowshoe hares become so small and fragmented that the landscape cannot support lynx home ranges (ILBT 2013, p. 77) or populations over time (68 FR 40077). Additionally, the presence of more snowshoe hare predators and competitors at southern latitudes may inhibit the potential for high-density hare populations (Wolff 1980, p. 128). As a result, lynx generally occur at relatively low densities in the contiguous U.S. compared to the high lynx densities that occur in the boreal forest of Canada when hares are abundant (Aubry *et al.* 2000, pp. 375, 393-394) or the densities of species such as the bobcat, which is a habitat and prey generalist.

Snow conditions also determine the distribution of lynx (Ruggiero *et al.* 2000b, pp. 445-449), which are morphologically and physiologically adapted for hunting snowshoe hares and surviving in areas that have cold winters with deep, fluffy snow for extended periods. These adaptations provide lynx a competitive advantage over potential competitors, such as bobcats or coyotes (McCord and Cardoza 1982, p. 748; Buskirk *et al.* 2000a, pp. 86-95; Ruediger *et al.* 2000, pp. 1-11; Ruggiero *et al.* 2000b, pp. 445, 450), which have a higher foot load (more weight per surface area of foot), causing them to sink into the snow more than lynx. Therefore, bobcats and coyotes cannot hunt efficiently in fluffy or deep snow and are at a competitive disadvantage to lynx. Long-term snow conditions presumably limit the winter distribution of potential lynx competitors such as bobcats (McCord and Cardoza 1982, p. 748) or coyotes. These adaptations may also help lynx avoid predators such as mountain lions (Squires and Laurion 2000, p. 346), which also have higher foot-loading (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, p. 123), making them less efficient in deep and fluffy snow conditions.

Based on verified historical data, lynx occurrence has been documented in 24 states in the contiguous U.S. (McKelvey *et al.* 2000a, 207-232) and, more recently, in a 25th after some of the lynx released into southwestern Colorado dispersed into northern New Mexico (Colorado Division of Wildlife 2000, p. 3; 74 FR 66938), which had previously lacked verified evidence of lynx occurrence (USFS 2009, entire; 74 FR 66940-66943). Of these, and based on our current understanding of lynx and hare habitat requirements, the Service concludes that records in at least 11 states (Connecticut, Illinois, Indiana, Iowa, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Pennsylvania, and South Dakota) most likely represent occasional dispersing lynx that arrived in places with no historic or recent evidence of the habitat quality or quantity necessary to support a persistent resident lynx population (68 FR 40099; 74 FR 66940-66942; 79 FR 54807, 54817). These states are not within the distribution of resident lynx in the DPS, and we conclude that they naturally lack the necessary habitat, hare densities, and snow

conditions and that they were not capable historically and are not capable now of supporting resident lynx populations.

The Service originally identified the DPS as occurring in forested portions of the remaining 14 states (Colorado, Idaho, Maine, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming; 65 FR 16052, 16085). Some of these states, and parts of others, are thought to have historically supported only dispersing lynx or to have only occasionally supported resident breeding lynx (68 FR 40099; 74 FR 66940). Such areas were included within the range of the DPS because of the possibility that lynx could establish small, local populations in them and perhaps contribute to the persistence of the DPS, though evidence of this was lacking (68 FR 40080; 74 FR 66938). In its 2003 remanded determination for the lynx DPS, the Service concluded that (1) potential lynx and hare habitats in Michigan, Oregon, Utah, Vermont, and Wisconsin were relatively small, isolated, and of marginal quality, and that available information suggested that these states did not historically or recently support resident lynx populations; (2) it was uncertain whether Colorado, New York, and Wyoming historically supported resident populations or only occasional dispersers; (3) New Hampshire probably supported a small resident populations that had been extirpated; and (4) the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) had the best historic and recent evidence of resident breeding populations (68 FR 40082, 40086-40095, 40097-40101). Below we provide our current understanding of these state groupings and the information available since the 2003 remand that informs this understanding.

Michigan, Oregon, Utah, Vermont, and Wisconsin - Additional information and analysis available since 2003 support the determination that Michigan (Linden 2006, pp. 83-90) and Oregon (Aubry 2006, pp. 1-2) did not historically or recently support resident lynx populations, and no evidence has emerged suggesting that resident populations occurred historically or recently in Utah or Wisconsin (ILBT 2013, pp. 45, 58). The best available information continues to suggest that resident lynx did not historically and do not currently occur in Michigan, Oregon, Utah, and Wisconsin; that habitats in these states are naturally incapable of supporting resident breeding populations; and that historic and potential future occurrences of lynx in these states most likely represent occasional dispersing lynx. We conclude, therefore, that these states did not historically, do not currently, and in the future are very unl kely to, contr bute to the persistence and conservation of lynx in the contiguous U.S.

In contrast, nine lynx occurrences were confirmed in the 530-km^2 (205-mi^2) Nulhegan Basin of northeastern Vermont from 2003 to 2014, and breeding was confirmed in 2012; intensified surveys since then have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). This new information indicates that this small area of northernmost Vermont is at least occasionally capable of supporting a small number of resident breeding lynx, but that its ability to support a persistent resident population over time remains doubtful. Based on assessments of the amount and quality of potential lynx and hare habitat, snow conditions, and the presence and distribution of lynx competitors and predators (Hoving *et al.* 2005, pp. 746-749; Bernier 2015, entire), we conclude it is unlikely that northern Vermont can support a persistent resident lynx population (79 FR 54820-54821); that it only occasionally

supports lynx reproduction when hare abundance and snow conditions are temporarily adequate; that it most likely represents a “sink” rather than a “source” for the regional lynx population, and that this likely represents its natural historical condition.

Colorado, New York, and Wyoming - When the Service listed the DPS in 2000, it believed that a resident lynx population occurred historically in the Southern Rocky Mountains of western Colorado and southeastern Wyoming, that lynx were also historically resident in northwestern Wyoming (part of the Northern Rocky Mountains), and that the Adirondack Mountains of northern New York may historically have supported a resident population that was by then extirpated (65 FR 16055-16056; 16058-16059). In the 2003 remand, the Service noted inconsistencies and l kely errors in historic lynx reports for the Southern Rockies, questioned its original conclusion that Colorado historically supported an isolated resident population, and concluded that it was uncertain whether a resident population occurred historically in Colorado or if historic records were of periodic dispersing lynx during “extremely high populations cycles” and that a resident population never existed in southeastern Wyoming (68 FR 40081, 40091). The Service also noted that in 1999 and 2000 the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) introduced 96 lynx from Canada and Alaska into southwestern Colorado (with plans to release an additional 186 lynx from 2003-2009) in an effort to reestablish a resident lynx population, that reproduction among some of the released lynx had been documented by 2003, but that it was too early to determine whether the program would be successful (68 FR 40091). In that rule, the Service also concluded that, despite evidence of reproduction in northwestern Wyoming (part of the GYA), potential habitat there is naturally marginal (patchier and composed of drier forest types), may be incapable of supporting a resident lynx population, and that lynx in northern Wyoming are most likely dispersers (68 FR 40090). Also in 2003, the Service concluded that it was possible resident lynx occurred in northern New York prior to 1900 but the potential habitat there is small, marginal, and likely has only supported dispersing lynx since then, and that an effort to reintroduce lynx there failed quickly, suggesting the habitat is incapable of supporting a resident population (68 FR 44486-44487).

In Colorado, after the initial release of 96 lynx in 1999 and 2000, none were released in 2001 or 2002 while protocols were evaluated and refined based on monitoring of the initially-released lynx (Shenk 2010, pp. 1, 4; Ivan *in* Lynx SSA Team 2016, p. 22). From 2003-2006, another 122 lynx were released, bringing the total to 218 (Devineau *et al.* 2010, p. 526). Reproduction was documented in 2003-2006 and 2009-2010, with 48 dens documented in that time, including a third generation of Colorado-born lynx (Shenk 2010, p. 5; Ivan *in* Lynx SSA Team 2016, p. 22). In 2010, CPW determined that all benchmarks for its lynx program had been met and had resulted in the establishment of a viable, self-sustaining lynx population (Ivan, 2011a, pp. 11, 12). Intensive monitoring of the population ceased in 2010 and was replaced by an effort to develop a minimally-invasive long-term monitoring program (Ivan 2011b, entire), which used snow-tracking surveys and camera traps to document continued lynx presence in the core release area of the San Juan Mountains in 2010-11 and again in 2014-15, with evidence of reproduction also documented during that time (CPW 2015, p.1; Ivan *in* Lynx SSA Team 2016, pp. 22-23). In its 2014 revised critical habitat designation for the DPS, the Service concluded

that the historic record of verified lynx occurrence in Colorado combined with naturally highly-fragmented and isolated potential habitat and generally low snowshoe hare densities suggest that Colorado and the Southern Rockies were unlikely to have historically supported a persistent resident lynx population and that the long-term persistence of the introduced population is uncertain (79 FR 54787-54789, 54793-54795, 54816-54817). The current size of the resident lynx population in Colorado is unknown but thought to number between 100 and 250 (Ivan *in* Lynx SSA Team 2016, p. 47). We continue to believe that available information suggests Colorado did not historically support a persistent resident lynx population and that the long-term persistence of the introduced population remains uncertain.

Information and analyses since the 2003 remand support the conclusion that New York has inadequate habitat quantity and quality (both vegetation and snow conditions) to support a resident lynx population (Hoving *et al.* 2005, pp. 746, 749). Based on Hoving *et al.* (2005) and our evaluation of the verified records of historic occurrence presented by McKelvey *et al.* (2000a, pp. 215-217), we conclude that the Adirondack Mountains of northern New York have not recently and likely did not historically support a persistent resident lynx population, are likely incapable of doing so, that verified historic records were most likely of dispersing lynx, and dispersing lynx may currently and in the future continue to occur rarely and temporarily in northern New York.

In northwestern Wyoming, additional information available since 2003 documented continued presence of a small number of lynx as recently as 2010, including some evidence of reproduction during that time, and documentation of Colorado-released lynx that dispersed into and through Wyoming (Squires *et al.* 2003, entire; Squires and Oakleaf 2005, entire; Murphy *et al.* 2006, entire; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Hanvey 2016, pers. comm.; Ivan 2016, pers. comm.; Murphy 2016, pers. comm.). However, more recent surveys and research-related trapping efforts have failed to detect lynx in this area or elsewhere in Wyoming since 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45). In the 2014 revised critical habitat designation, the Service noted:

> Although the GYA has a long history of lynx presence and recent evidence of reproduction (Squires and Laurion 2000, entire; Squires *et al.* 2001, entire; Murphy *et al.* 2006, entire), there are relatively few verified records of lynx from Yellowstone National Park and surrounding areas (65 FR 16058, 68 FR 40090). Additionally, lynx habitat in the GYA is naturally marginal (patchier and composed in many places of drier forest types), less capable of supporting snowshoe hares (Hodges *et al.* 2009, entire), and farther from source populations than most other parts of the DPS range (68 FR 40090). Given the naturally marginal habitat in this largely protected area, we believe it is unlikely that the GYA ever supported more than a handful of lynx home ranges in any given year. We find no evidence that the GYA once supported a larger or more robust lynx population than the small one suggested by verified historic and recent records and survey efforts (79 FR 54791).

We concluded that the historic record and recent evidence of lynx occupancy and reproduction suggested the presence of a small but persistent resident lynx population in the GYA of northwestern Wyoming and southwestern Montana (79 FR 54791, 54796-54797, 54825-54826); however, the consistency of occupancy over time remains uncertain (Lynx SSA Team 2016, pp. 11, 45, 57). Uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016, p. 57). If residency was intermittent historically, the current apparent absence of resident lynx might be a natural condition related to the area's largely marginal or suboptimal habitat conditions - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. In that case, future intermittent residency would be expected, but only if lynx dispersing from a source population immigrate to the GYA when habitat conditions and hare densities return to more favorable levels. Conversely, if the GYA always historically supported a small number of resident lynx but no longer does, it may suggest that some factor or factors have acted to tip the quality of the area's habitat from just barely capable of supporting a small resident population to no longer capable of doing so, resulting in extirpation. We conclude that this uncertainty cannot be resolved based on the available information but, given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its historic inability to support a robust, persistent resident population and its apparent recent inability to support any resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. We also note that extensive areas of the GYA were burned by the large, intense wildfires of 1988, and that these areas may soon (perhaps in the next 5-15 years) regenerate to a stage containing the dense horizontal conifer structure favorable for hares and, therefore, lynx foraging habitat, perhaps increasing the l kelihood that the GYA may support resident lynx again in the near future (Lynx SSA Team 2016, p. 46).

In southern Wyoming, all recent occurrences of lynx appear to be of Colorado-released lynx that moved into or through the area (see Devineau *et al.* 2010, Fig. 1, p. 526), including one female who in 2004 established a den in the Snowy Mountains and produced kittens that did not survive (Bjornlie 2016, pers, comm.; Ivan 2016, pers. comm.). Based on the available information, we conclude that southern Wyoming did not historically or recently support a resident lynx population and is not now capable of doing so.

New Hampshire - There were 18 confirmed lynx records indicating 28 individual lynx in northern New Hampshire from 2006 to 2013, with evidence of reproduction in 2010 and 2011 (79 FR 54820). An additional 8 lynx detections were documented in 2014 (Siren 2014, p. 7), 24 lynx track intercepts were recorded during snow-tracking surveys during the winter of 2014-2015 (Siren 2016, p. 1), and surveys in 2016 also detected lynx (Siren 2016, pers. comm.). Most records since 2006 are in the vicinity of Pittsburg in the northernmost reaches of the state, though lynx detections in 2015 and 2016 suggest a southern expansion from the area of 2006-2014 detections (Siren 2016, p. 1; Siren 2016, pers. comm.). Despite recent evidence of lynx

residency and reproduction, the Service concluded in the 2014 revised critical habitat designation that, based on modeling of the amount of potentially suitable habitat and favorable snow conditions (Hoving *et al.* 2005, pp. 739, 749; Litvaitis and Tash 2005, p. A-298), it is unlikely that northern New Hampshire will support a resident breeding population over the long-term (79 FR 54820-54821). Siren (2014, p. 10) suspected that the relatively few lynx detections documented in 2012-2014 may be related to the presence and abundance of bobcat, coyote, and fisher populations in northern New Hampshire. We conclude that northern and central New Hampshire likely supported a small resident lynx population historically that was extirpated during the latter half of the 20th century. We are uncertain whether lynx detections in northernmost New Hampshire over the past decade may represent the natural reestablishment of a small resident breeding population in the state or if it is a temporary phenomenon related to an expanding source population in neighboring northern Maine (79 FR 54821). Although bobcat populations have increased and expanded their range in this region in recent decades (Lavoie *et al.* 2009, pp. 873-874), severe winters and deep snow can substantially limit their populations (Reed 2009, pp. 29-33; McCord, 1974, pp. 433-434). Maine's bobcat harvest declined substantially after two deep snow winters in 2008 and 2009 (Maine Department of Inland Fisheries and Wildlife 2015, p. 37). It is possible that these anomalous deep snow winters provided a temporary competitive advantage to lynx in northern New Hampshire.

Idaho, Maine, Minnesota, Montana, and Washington - These states (along with New Hampshire, above) have the strongest historical evidence of continuous lynx presence and recent evidence of resident lynx populations (McKelvey *et al.* 2000a, pp. 211-228; 68 FR 40086-40095, 40097-40101; McKelvey *in* Lynx SSA Team 2016, p. 11). Historic lynx records exist for much of Idaho, but many, especially in the central and southern part of the state, occurred in anomalous habitats or were associated with large irruptions of lynx from Canada to the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 225-227). The historic record and recent surveys (summarized at 79 FR 54818-54820; also see U.S. District Court ID 2016, pp. 18-24) suggest that only dispersing lynx occur throughout most of Idaho, habitats in many parts of the state are drier forest types that support lower densities of hares, and resident lynx seem to be confined to the Purcell, Selkirk, and possibly the Cabinet mountain ranges in the northern panhandle. The number of resident lynx in northern Idaho is unknown but certainly small based on the amount of potential habitat, and resident lynx here are part of a larger population that occurs primarily in northwestern Montana and southeastern British Columbia.

Maine has a long history of continual lynx presence, with evidence of a persistent resident population in much of the northern half of the state, which currently supports the largest lynx population in the DPS (Krohn 2010, entire; McKelvey *et al.* 2000a, pp. 211-212; Hoving *et al.* 2003, entire; Vashon *et al.* 2012, pp. 50-60; 79 FR 54784-54785, 54792, 54822-54824; Vashon *in* Lynx SSA Team 2016, p. 18). The lynx population in Maine is much larger than was suspected at the time of listing or the 2003 remand (potential habitat exists to support possibly 750-1,000+ individuals [Vashon *in* Lynx SSA Team 2016, p. 18], though a reliable population estimate is lacking). The current abundance of lynx is supported by the broad distribution of high-quality hare habitat that resulted from extensive, large-scale clearcutting in the 1970s and

1980s in response to a massive spruce budworm outbreak (68 FR 40087; 79 FR 54792; also see section 4.1.1, below). As these regenerating clearcuts, which currently provide the dense horizontal structure preferred by hares, mature beyond about 35 years post-harvest, hare densities decline as cover and forage are reduced due to forest succession (Simons 2009, p. 217). The current lynx population is probably larger than the likely historic condition, when relatively small amounts of the spruce-fir forests in the state are thought to have been composed of young stands (Lorimer 1977, entire; 68 FR 40094; Vashon *et al.* 2012, pp. 45, 56; 79 FR 54792). With the reduction in clearcutting following enactment of the Maine Forest Practices Act of 1989, it is projected that lynx densities in Maine will decline by 55 to 65 percent by 2032 (Simons 2009, p. 217). Lynx in Maine likely represent the southern periphery of a larger population that occurs in northern New Brunswick and southern Quebec south of the St. Lawrence Seaway/River, which appears to partially isolate lynx in this region, demographically and genetically, from populations in the core of the species' range (Koen *et al.* 2015, entire). The extent to which lynx persistence in Maine relies on immigration from Canada is unknown.

In Minnesota, research conducted since the 2003 remand has demonstrated the continuous presence of a resident lynx population in the northeastern part of the state that seems to be the southern periphery of a larger population in southwestern Ontario (Moen *in* Lynx SSA Team 2016, pp. 19, 39). The number of resident lynx in Minnesota is unknown but believed to be between 50 and 200 (Moen *in* Lynx SSA Team 2016, pp. 19, 39). Lynx are occasionally detected in other parts of the state, but hare densities and snow conditions consistently favorable for lynx appear to be restricted to the northeastern "Arrowhead" region of the state, and areas to the south and west are dominated by bobcats. Although there are currently more lynx in Minnesota than suspected at the time of listing, it is unclear whether current numbers and distr bution are similar to the historical condition. The extent to which lynx persistence in Minnesota relies on immigration from Canada is also unknown.

In Montana, research conducted since the DPS was proposed for listing has documented the continued presence and broad distribution of resident lynx in much of the northwestern portion of the state (Squires *in* Lynx SSA Team 2016, p. 20). The number of resident lynx in northwest Montana is unknown but believed to be between 200 and 300 (Squires *in* Lynx SSA Team 2016, p. 41) in three subpopulations - the Purcell Mountains, Seeley Lake/Central, and Garnet Mountains subpopulations (Squires *in* Lynx SSA Team 2016, p. 20). Recent (2014-2015) surveys failed to detect lynx in the Garnet Mountains in the southern part of the area (Squires *in* Lynx SSA Team 2016, p. 20), which had residents as recently as 2010 and is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.). Lynx in northwestern Montana (and northern Idaho) likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia. The extent to which lynx persistence in this area relies on immigration from Canada is unknown, and there is no indication of substantial immigration from Canada after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). In southwest Montana, few lynx and no recent evidence of reproduction have been documented in the Montana portion of the GYA where, as with the northwestern Wyoming part of the GYA (discussed above), uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent

apparent absence from the area (Lynx SSA Team 2016, p. 57). As elsewhere in the West, recent research and habitat assessments suggest that habitats capable of supporting resident lynx in Montana are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12).

In Washington, research and monitoring conducted since the 2003 remand has continued to document a resident lynx population in the Okanogan region of the eastern Cascade Mountains in the north-central part of the state (von Kienast 2003, entire; Maletzke 2004, entire; Koehler *et al.* 2008, entire; Maletzke *et al.* 2008, entire; Maletzke *in* Lynx SSA 2016, pp. 21-22). Since at least 1985, this is the only area of the state with evidence of a resident breeding population (Koehler and Maletzke 2006, p. 4; Koehler *et al.* 2008, p. 1518; ILBT 2013, p. 58; Maletzke *in* Lynx SSA 2016, p. 21), although the Kettle Mountains in the northeastern part of the state are thought to have historically supported a small breeding population, and lynx are detected there occasionally (Stinson 2001, pp. 13–14; Koehler *et al.* 2008, p. 1523; USFWS 2008, p. 2). Multiple large fires in the Okanogan over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). Although these areas should regenerate into lynx and hare habitat, it may take 35-40 years (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and insect impacts could further diminish habitat availability and the lynx population's probability of persistence (Lynx SSA Team 2016, p. 44; see also sections 3.4, 4.1.4, and 5.1.4, below).

In summary, although uncertainty remains regarding the historic distribution of resident lynx in the DPS and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population declines in the contiguous U.S. from historical conditions until the DPS was listed have been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11). New information summarized above indicates that there are many more lynx in Maine and Minnesota than was suspected at the time of listing, and there are naturally fewer lynx and a more limited distribution of suitable habitats in the western U.S. than was previously thought (68 FR 40085, 40091-40092; ILBT 2013, p. 23). Lynx in Maine are at historically high numbers and may currently be facilitating the recolonization of formerly occupied habitat in northern New Hampshire, though lynx persistence in New Hampshire is uncertain and lynx numbers in Maine are projected to decline over the next several decades. In the West, small breeding populations in the GYA and the Garnet Mountains of Montana may recently have become extirpated (although both also may be only temporarily "winked off" in a metapopulation dynamics sense). In north-central Washington, lynx habitat and numbers have declined because of recent large fires and insect outbreaks, and the persistence of the breeding population there could be threatened if additional such impacts occur with similar magnitude and frequency over the next several decades. As a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, resident lynx currently occur in western Colorado. Although the number of lynx in this population and its future persistence are uncertain, Colorado currently

supports more lynx than it likely did, based on the historic record, for much of the previous century. The geographic units evaluated in this SSA include all areas in the contiguous U.S. with strong historical and recent evidence of persistent resident lynx populations. Detailed assessments of the current status and future viability of resident lynx populations and habitats in these areas are presented in chapters 4 and 5 below.

Chapter 3: Factors Influencing Viability of the DPS

In this chapter we discuss factors thought to influence the historic and current distribution and status of lynx populations in the contiguous U.S., their likely influence on the future viability of the DPS, and we describe the cause-and-effects pathways of impacts associated with particular factors. We focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in federal land management plans at the time of listing) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68-78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS.

3.1 Regulatory Mechanisms

A number of activities with the potential to affect lynx habitat suitability, productivity, mortality, and movements via habitat loss or fragmentation, creation of barriers, or that otherwise alter the vegetation mosaics and prey abundances maintained historically by natural disturbance processes may occur in lynx habitats regardless of land ownership and management. The extent to which regulations guide such activities to avoid, minimize, or mitigate impacts to lynx influences the current and future likelihoods that those habitats will provide the physical and biological features needed to support resident lynx populations. As described in more detail below, the lynx DPS was listed as threatened because of the lack of specific conservation direction and associated regulations on federal lands. At that time, the available information indicated that most lynx habitat in the DPS occurred on federal lands, predominantly in the western U.S. (65 FR 16061). Since then, research and monitoring have revealed that non-federal lands contribute more to the conservation of the DPS than was known at the time of listing, particularly in the Northern Maine and Northeastern Minnesota regions. Therefore, in the following sections we describe and compare the federal regulatory environment for lynx in the DPS at the time of listing and currently, and we describe other regulatory mechanisms as they pertain to lynx on private as well as State and Tr bal lands.

Since it was listed in 2000, the DPS has been protected by the ESA’s prohibition on take (under section 9), which applies to lynx wherever they occur in the DPS, regardless of land ownership. The DPS has also been protected since listing by section 7 of the ESA, which requires federal agencies to use their authorities to conserve listed species and to consult with the Service for any actions they implement, fund, or permit (i.e., for which a “federal nexus” exists) and which

may affect lynx or lynx habitats within the DPS, again regardless of land ownership. Additionally, section 4 of the ESA requires that critical habitat, defined as the specific geographic areas containing the physical and biological features essential for the conservation of a listed species and that may require special management and protection, be designated for listed species, and section 7 prohibits the destruction or adverse modification of such designated habitats. Critical habitat was designated for the lynx DPS in 2007 and was revised in 2009 and 2014. Section 4 also requires recovery planning for listed species; a recovery plan for the lynx DPS has not yet been completed, but part of the purpose of this SSA is to inform near-term recovery planning direction.

3.1.1 Federal Regulatory Mechanisms

Federal lands make up approximately 64 percent of the lands encompassed by the six geographic units evaluated in this SSA. Of those federal lands, roughly 87 percent is managed by the U.S. Forest Service (USFS), 11 percent by the National Park Service (NPS), and 2 percent by the Bureau of Land Management (BLM). The amount of federal land varies by unit, ranging from 0 percent in the Northern Maine Unit to over 97 percent in the GYA Unit (see Table 1, above, and Chapter 4, below, for ownership in each geographic unit). Federal lands management is guided by a number of statutes and associated regulations, policies, standards, guidelines, and best management practices applied by managing agencies to meet legislative mandates and achieve agency missions (for a summary of relevant Acts and associated regulations and guidance, see USFWS 2014, pp. 24-34). Many of these regulatory mechanisms provide some benefits to lynx and protect lynx habitats (USFWS 2014, pp. 24-34). For example, the conservation priority in the management of NPS lands in accordance with the National Park Service Organic Act (16 USC 1 et seq. as amended), the National Parks and Recreation Act (Public Law 95-625), and the Wilderness Act (16 USC 1131-1136, 78 Stat. 890) likely provides an adequate regulatory framework for the conservation of lynx populations and habitats in the NPS units in which they occur (USFWS 2014, pp. 28-29, 31-33). However, it was the absence of specific management direction and conservation measures for lynx and lynx habitats in USFS and BLM land management plans that led the Service to conclude that the regulatory mechanisms in those plans at the time of listing were inadequate to provide for the conservation of the DPS. Therefore, the evaluation below focuses on the efforts of USFS and BLM, in collaboration with the Service, to address the regulatory inadequacy for which the DPS was listed.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx populations and potential lynx habitats (broad forest vegetation classes defined as “lynx forest types” [65 FR 16071]) in the contiguous U.S. occurred on federal (USFS, NPS, and BLM) lands in the western states, and that the plans that guided management of those lands (particularly USFS and BLM lands) included “...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species” (65 FR 16052, 16082). At that

time, the Service found that USFS and BLM management plans did not adequately address risks to lynx and, as identified in the LCAS (Ruediger *et al.* 2000, pp. 2-1 through 6-3), those plans allowed actions that cumulatively could result in significant detrimental effects to lynx in the contiguous U.S. As a result, the Service concluded in the final rule that the lack of federal Land Management Plan guidance for the conservation of lynx and the potential for those plans to allow or direct actions that could adversely affect lynx constituted a significant threat to the DPS (68 FR 40096).

In 1998, in anticipation of the DPS's listing under the ESA, regional and state directors of the Service, USFS, BLM, and NPS approved preparation of the interagency LCAS to provide a consistent and effective approach to conserve lynx and to assist with Section 7 consultation on federal lands. An interagency Steering Committee selected a Science Team to assemble the best available scientific information on lynx and appointed the ILBT to prepare a lynx conservation strategy applicable to federal land management in the contiguous U.S. (USFWS 2014, p. 15). The first edition of the LCAS was completed in January, 2000 and revised in August, 2000 (Ruediger *et al.* 2000, entire). The Steering Committee subsequently issued several amendments and clarifications, and the most recent revision of the LCAS was completed in August, 2013 (ILBT 2013, entire). The LCAS initially identified and evaluated 17 risk factors (e.g., timber and fire management, recreation, roads, livestock grazing, trapping, etc.) thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements, and that may be addressed under programs, practices, and activities within the authority and jurisdiction of federal land management agencies. These risk factors included programs or practices with the potential to result in habitat conversion, habitat fragmentation, or obstruction to lynx movement; roads or winter recreation trails that may facilitate access to historical lynx habitat by competitors; and fire suppression, which changes the vegetation mosaic maintained by natural disturbance processes. The risks identified in the 2000 LCAS were based on potential effects to lynx habitats and to individual lynx, lynx populations, or both; therefore, not all of the risks initially identified in the LCAS were thought to threaten lynx populations in the DPS (68 FR 40096). In the 2013 revised LCAS, risk factors were redefined as "Anthropogenic Influences on Lynx and Lynx Habitat," and grouped into two tiers based on the potential magnitude of effects (ILBT 2013, pp. 1, 68). First tier influences (climate change, vegetation management, wildland fire management, and habitat fragmentation - discussed in the remainder of this chapter, below) are those with potential to negatively affect lynx populations and habitats, while second tier influences are those that may affect individual lynx but are not expected to substantially impact populations or habitats (ILBT 2013, pp. 68-85).

In addition to identifying risks, the LCAS also directed federal agencies to map potential lynx habitat and identify lynx analysis units (LAUs) to evaluate potential impacts of management actions on lynx and snowshoe hare habitats. Finally, the LCAS developed recommended conservation measures, standards, and guidelines to be applied to lynx habitats on federal lands that were designed to mimic historic conditions and landscape-scale disturbance patterns and to maintain or improve lynx and hare habitats at both local (project-level) and landscape scales (USFWS 2014, p. 16). After its initial completion in 2000, USFS and BLM managers within the range of the DPS agreed to implement the standards and guidelines identified in the

LCAS until management plans could be formally amended to specifically address lynx conservation. In 2000, the Service, USFS, and BLM developed and adopted Canada Lynx Conservation Agreements (CAs; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire) in which the BLM and USFS agreed to coordinate assessment and planning efforts with the Service to assure a comprehensive approach to lynx conservation and to use the LCAS, supporting science, and locally specific information as the basis for the approach and to streamline consultation under section 7 of the ESA. The USFS further committed to deferring any actions not involving third parties that would adversely affect lynx until such time as the Forest Plans were amended or revised to adequately conserve lynx (USFS and USFWS 2000, p. 8; 68 FR 40083).

Concurrent with development of the LCAS and interagency CAs, the USFS and BLM in 1999 completed the *Biological Assessment* (BA) *of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx* (USFS and BLM 1999, entire). The BA identified and evaluated the potential effects to lynx of implementation of 57 USFS Land and Resource Management Plans and 56 BLM Land Use Plans throughout the 14 states in which the lynx DPS was proposed for listing. The BA concluded that the potential for adverse effects to lynx existed on each administrative unit in each geographic area and that, cumulatively, implementation of the existing plans was likely to adversely affect the DPS. It recommended that all of the plans be amended or revised to incorporate conservation measures to reduce or eliminate adverse effects to lynx (USFS and BLM 1999, p. 14). In its 2000 biological opinion on the BA, the Service evaluated the USFS and BLM plans in conjunction with the CAs described above (USFWS 2000, p. 15). The Service concluded that implementation of the existing plans in accordance with the CAs until plans could be formally amended or revised was not likely to jeopardize the DPS, but that amendments or revisions to those plans were needed to further reduce or avoid the potential for adverse effects to lynx (USFWS 2000, pp. 48-50).

In the 2003 remanded rule, the Service similarly determined that adherence to the CAs, the biological opinion, and the LCAS in assessing the impacts of federal actions on lynx alleviated the effects of federal land management activities on lynx, but that amendment of USFS and BLM land management plans to conserve lynx would be the strongest mechanism to ensure long-term conservation of lynx and lynx habitat on federal lands (68 FR 40096-97). It concluded that although federal, State, and Tribal regulations and plans had reduced threats to the DPS, the inadequacy of existing regulatory mechanisms still posed a moderate, albeit lower-level threat, and would continue to do so until federal land management plans were specifically amended to address lynx conservation (68 FR 40097).

Since the 2003 remand, most Forest Service units with lynx forest types have formally amended or revised their land management plans to incorporate the conservation measures, standards, and guidelines identified in the LCAS. From 2004-2006, forest plans for seven national forests with potential lynx habitat in Maine, New Hampshire, Vermont, Michigan, Minnesota, and Wisconsin were revised to include recommendations from the LCAS and the CAs (Jackson 2015, pers. comm.; USFWS 2104, p. 33). In 2007, the USFS completed the Northern Rockies

Lynx Management Direction (NRLMD), which formally amended management plans to include lynx conservation measures, standards, and guidelines for 18 national forests covering over 150,000 km^2 (57,915 mi^2) in Idaho, Montana, Wyoming and Utah, including over 72,000 km^2 (27,800 mi^2) of potential lynx habitat (USFS 2007, entire; USFWS 2014, pp. 16-19; 79 FR 54813; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). In 2008, USFS similarly completed the Southern Rockies Lynx Amendment (SRLA), which formally amended forest plans covering about 59,000 km^2 (22,780 mi^2), including over 30,000 km^2 (11,583 mi^2) of mapped (potential) lynx habitat on 7 national forests or national forest complexes in western Colorado and southern Wyoming (USFS 2008, entire; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). The management direction adopted in the Northern and Southern Rockies amendments was developed in accordance with the National Forest Management Act of 1976 and the regulations that implement the statute (36 CFR 219.22), which requires public review and comment as part of the decision making process. Among national forests within the geographic units evaluated in this SSA, only those in Washington (the Okanogan-Wenatchee and Colville national forests) have not formally amended or revised their land and resource management plans. However, the plan revision process has been initiated for both forests, and both continue to manage for lynx habitats in accordance with the LCAS and the CA.

BLM lands account for just over 1 percent of the total area within the SSA geographic units, and most occur in Colorado, Montana, and Wyoming (Table 1, above). In the Western Colorado SSA unit, BLM Field Offices that contain potential lynx habitat include the Colorado River Valley, Grand Junction, Gunnison, Kremmling, Little Snake, Royal Gorge, San Luis Valley, Tres Rios, Uncompahgre, and White River Field Offices. These BLM areas were subject to the 2000 interagency CA; however, that CA expired in 2004 (BLM and USFWS 2000, p. 8) and was not renewed. Since then, BLM Resource Management Plans (RMPs) have been revised on the Colorado River Valley, Grand Junction, Kremmling, Little Snake, and Tres Rios Field Offices. RMPs for the Gunnison, Royal Gorge, San Luis Valley, Uncompahgre, and White River Field Offices have not been revised and do not contain specific measures for the conservation of lynx. BLM lands in the Garnet Resource Area in Montana and parts of the Kemmerer and Pinedale districts in Wyoming occur within the Northwestern Montana/Northeastern Idaho and GYA SSA geographic areas, respectively. These areas were also designated as lynx critical habitat. The RMP for the Garnet area was amended in 2004 to formally adopt the conservation measures of the LCAS (BLM 2004a, 2004b, entire), and the RMPs for the Pinedale and Kemmerer districts were revised in 2008 and 2010, respectively, to adopt conservation measures and best management practices for lynx (BLM 2008b, pp. A18-10 - A18-16; BLM 2010b, pp. A-9 - A-12).

The completion and implementation of the LCAS, the interagency CAs, and the subsequent formal management plan revisions and amendments all were undertaken to address the inadequacy of regulatory mechanisms on USFS and BLM lands for which the DPS was listed. Each incorporated the best available scientific information to develop goals, objectives, conservation measures, standards, and best management practices (BMPs) to guide USFS and BLM management activities at both project- and landscape-level scales to reduce or eliminate the potential for adverse effects to lynx or its habitats and thus promote the conservation of the DPS (Ruediger *et al.* 2000, pp. 7-1 - 7-18; BLM and USFWS 2000, entire; USFS and USFWS

2000, entire; USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). Standards and guidelines developed and implemented in accordance with the NRLMD and the SRLA were designed to limit potentially adverse effects and promote beneficial effects of management activities (vegetation management [e.g., timber harvest, precommercial thinning], wildland fire and fuels management, grazing, recreation, road/access management, energy development, etc.) on important lynx habitats including winter snowshoe hare habitat (high-quality lynx foraging habitat), denning habitat, and linkage/connectivity corridors (USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). The USFS concluded that the vegetation standards adopted in the NRLMD that limit the total amount and the rate at which lynx habitat can be converted to temporarily unsuitable habitat (stand initiation seral stage following timber harvest) ensure that the agency's timber management program is beneficial to lynx and will provide sufficient lynx habitat through time at both LAU and landscape-level scales (USFS 2007, p. 35). In its biological opinion on the NRLMD, the Service concluded that its application "...would substantially reduce or eliminate adverse effects to lynx from Forest Service land management activities on at least 94 percent of this area, and more likely nearer to 98 percent" (USFWS 2000, p. 76). Similarly, in its 2008 biological opinion on the SRLA, the Service concluded that vegetation management standards in the SRLA would proh bit treatments that could adversely affect essential components of lynx habitat on 95.5 percent of the mapped (potential) lynx habitat in the SRLA area (USFWS 2008, p. 52).

In summary, all USFS and some BLM lands with known or potential lynx habitat within the range of the DPS, including all SSA geographic units, are currently managed in accordance with the specific conservation measures and considerations identified in the LCAS and implemented via the CAs or formally revised and amended management plans described above. These agreements and revised/amended plans constitute the regulatory framework and specific regulatory mechanisms adopted to conserve lynx habitats and populations on USFS and BLM lands that support or are capable of supporting them. They represent the agencies' efforts, in collaboration with the Service, to address and ameliorate the singular threat for which the lynx DPS was listed under the ESA. Although formal effectiveness monitoring has not been completed, it's clear that implementation of the CAs and revised/amended plans, and the associated programmatic and project-specific consultations between BLM/USFS and the Service in accordance with section 7 of the ESA, have resulted in avoidance/minimization of impacts to important lynx and hare habitats on federal lands and have reduced the likelihood that management activities on these lands may adversely affect lynx in the contiguous U.S.

3.1.2 State Regulations and Tribal Management

Private, State, and Tribal lands make up the remaining 36 percent of the lands encompassed by the six geographic units evaluated in this SSA, accounting for almost 27 percent, almost 9 percent, and 1 percent of the total, respectively (Table 1). The amount of private land varies by unit, ranging from 0.3 percent in the North-central Washington Unit to almost 92 percent in the Northern Maine Unit. Likewise, State ownership varies from less than 1 percent in the GYA and Western Colorado units to 36 percent in the Northeastern Minnesota Unit. Tr bal lands account for about 4 percent of the Northwestern Montana/Northeastern Idaho Unit and roughly 1 percent

of the Northern Maine and Northeastern Minnesota units; there are no Tr bal lands in the North-central Washington, GYA, or Western Colorado units. Private, State, and Tribal lands, combined, constitute all of the lands in the Northern Maine Geographic Unit and over half of those in the Northeastern Minnesota Unit. Because both of these units support larger resident lynx populations than was known when the DPS was listed and, therefore, may contribute more substantially to the conservation of the DPS than was understood at the time of listing, we must evaluate the regulatory mechanisms that pertain to lynx on these lands (Lynx SSA Team 2016, p. 54). Although private, State, and Tribal lands constitute much smaller proportions of the other four (western) geographic units (from about 3 percent to 16 percent, combined), important lynx habitats occur on some of those lands, and regulatory mechanisms may influence their contributions to the conservation and persistence of DPS populations or parts of them. Therefore, in this section, we summarize the relevant regulatory frameworks and mechanisms that may affect lynx on private, State, and Tribal lands within the six geographic units of the DPS, but with a focus on those units with the greatest proportions of these lands and on activities on these lands with the greatest potential to impact lynx.

State Wildlife Management Regulations - The following information is derived from the Service's 2014 Incremental Effects Memorandum prepared in support of the revised designation of critical habitat for the lynx DPS (USFWS 2014, pp. 35-38) and updated as warranted by new information. State furbearer and other wildlife management regulations benefit lynx populations in the states where they occur. In addition to State and private lands, State wildlife regulations govern hunting and trapping activities on many federal lands where those activities are permitted. Most states within the range of the lynx prohibited trapping and hunting of lynx prior to the 2000 listing of the DPS under the ESA, and those activities were prohibited in all states once the DPS was listed. All states within the lynx DPS range that allow legal bobcat harvest (1) manage in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Export Program for Appendix II Furbearer Species (USFWS 2014, pp. 25-26), (2) have distributed information to bobcat trappers and hunters on how to avoid incidental take of lynx, and (3) report all known incidences of incidental take of lynx to the Service's Division of Management Authority to assure that take does not exceed the amount permitted under the intra-agency section 7 consultation for the CITES Export Program (USFWS 2001, entire). Most states have also adopted special regulations in areas where lynx occur to minimize the potential for incidental take of lynx during legal trapping of other furbearers. These efforts benefit lynx and are expected to do so in the future with continued implementation and enforcement.

Unit 1: Northern Maine - In 1967, a bounty on lynx in Maine was repealed, and lynx were given complete protection from trapping and hunting. The Maine Department of Inland Fisheries and Wildlife (MDIFW) has adopted special trapping regulations where lynx may occur that address specifics about traps types and sets that may be used to legally harvest other furbearers and that are intended to minimize the likelihood of incidentally trapping lynx (http://www.eregulations.com/maine/hunting/lynx-protection-zone-trap-restrictions/). MDIFW also adopted and made available for download on its web page the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*, and

modified it to be more specific to Maine. MDIFW also set-up an incidental lynx capture hotline and requires that all incidentally trapped lynx be reported (http://www.maine.gov/ifw/hunting_trapping/trapping/avoid_lynx.htm, last accessed 8.08.2016), and has staff on stand-by to help immobilize, evaluate, collect tissue and/or hair samples, and release, if appropriate, any lynx reported to the hotline. This program has resulted in the release of 98 lynx from 2000 - 2015 (10 died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine (MDIFW 2014, p. 75). In 2014, the MDIFW obtained an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping in Maine. After two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx (see Other Factors in section 4.1.1 below). The regulations now require exclusion devices on killer-type traps, prohibit the use of drag sets on foothold traps, address specific trap types and sets, prohibit visual use of bait and visual attractants, swivels on chains, and require reporting of incidental captures. The trapping permit is currently being litigated in federal court. The MDIFW also is responsible for implementing the Maine Endangered Species Act (http://www.mainelegislature.org/legis/statutes/12/title12sec12803.html; MDIFW 2009, p. 9). Although the lynx is not State-listed as threatened or endangered because its population is estimated to exceed the State's listing threshold, it is considered a species of special concern (MDIFW 2011, p 2). The MDIFW works collaboratively with the Service to conduct research and monitor lynx populations and habitats, and it recommends voluntary forest management activities to promote a sustainable supply and large, connected, and widely-distributed blocks of dense, young spruce-fir stands and to conserve large blocks of unfragmented forestland in northern and western Maine (MDIFW 2011, p. 3).

Unit 2: Northeastern Minnesota - Although lynx were unprotected and had a bounty placed on them in Minnesota prior to 1965, lynx trapping and hunting have been prohibited in Minnesota since 1984 (Moen *in* Lynx SSA Team 2016, p. 19). Overlapping the Northeastern Minnesota SSA unit, the State Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ) for which it has promulgated and enforces special trapping regulations for other furbearers in lynx habitat. The MNDNR has modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (pages 52-54 at: http://files.dnr.state.mn.us/rlp/regulations/hunting/2013/full_regs.pdf). In 2015, the MNDNR issued emergency trapping rules in the LMZ mandating additional restrictions on the types of traps that may be used (MNDNR 2015, entire) to further reduce the likelihood of incidentally trapping lynx. Minnesota DNR is under a federal court order to develop an incidental take plan for lynx and plans to seek an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping. Like Maine, Minnesota has a State Endangered Species Statute (84.0895) which requires the Minnesota DNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern (State of Minnesota 2015, entire). The Statute also authorizes the DNR to adopt rules that regulate treatment of species designated as endangered and threatened. Also like Maine,

Minnesota has designated the lynx a species of special concern (MNDNR 2013, p. 2), and coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats.

Unit 3: Northwestern Montana/Northeastern Idaho - Lynx are designated as a species of concern (S3) by the State of Montana and a species of greatest conservation need (S1) by by the State of Idaho (ILBT 2013, p. 57). The harvest of lynx was prohibited in Idaho and Montana beginning in 1996 and 1999, respectively. Both States participate in the CITES Export Program for bobcats, and both have promulgated and enforce special regulations for the legal trapping of other furbearers in areas occupied by lynx. In its trapping regulations, Idaho Fish and Game (IDFG) provides information on how to distinguish between bobcats and lynx and provides guidelines to reduce injury and minimize non-target catches, including lynx (IDFG 2016, pp. 36-37). Guidelines recommend (1) a minimum 8-pound pan tension on foothold traps set for wolves, (2) specific trap types and sets for other furbearers, and (3) bait and habitat considerations when making sets. Trappers are also required to contact IDFG or local sheriff's offices to assist with the safe release of incidentally trapped lynx. In response to a lawsuit after several lynx were incidentally trapped recently in northern Idaho, the U.S. District Court for the District of Idaho ordered the State to submit "a plan to protect the lynx from future incidental takes in the Panhandle and Clearwater (northern) Regions of Idaho" (U.S. District Court ID 2016, pp. 25-26). The plan has not yet been completed and negotiations between the State and the court are ongoing (Sallabanks 2016, pers. comm.). To minimize and track the incidental capture of lynx, Montana Fish, Wildlife, and Parks (MTFWP) has promulgated an evolving set of trapping regulations and reporting requirements since the DPS was listed (MTFWP 2016, pp. 7-10), including significant changes in 2008 that reduced the reported rate of incidental lynx captures from 1.6 per year in 2000-2007 to 0.4/year in 2008-2015 (MTFWP 2016, p. 5). In 2015, the Federal District Court of Montana approved a settlement agreement reached between the State of Montana and conservation groups aimed at protecting lynx from trapping. The case is now dismissed in accordance with the agreement, which requires Montana to implement a set of reasonable restrictions on trapping in lynx habitat. Currently, these regulations identify designated lynx protection zones (LPZs) and define acceptable trapping methods for public lands within them, which (1) prohibit the use of lethal (non-relaxing) snares for bobcats, (2) specifies the types of sets and baits or attractants that may be used for marten, fisher, and other furbearers where lynx occur, (3) requires a minimum 10-pound pan tension on foothold traps set for wolves, and (4) requires that any incidentally trapped lynx must be released unharmed if possible and reported to MTFWP (MTFWP 2016, pp. 7-10). MTFWP is also responsible for implementing Montana's Nongame and Endangered Species Conservation Act (http://leg.mt.gov/bills/mca/87/5/87-5-103.htm; https://www.animallaw.info/statute/mt-endangered-species-chapter-5-wildlife-protection#87-5-107).

Unit 4: North-central Washington - Lynx harvest was prohibited in Washington in 1991, and the lynx was listed as a State threatened species in 1993 and proposed for uplisting to endangered in 2016 (Lewis 2016, pp. *iii*, 1). Under the State's Endangered Species Program, the Washington Department of Fish and Wildlife (DFW) developed a Lynx Recovery Plan (http://wdfw.wa.gov/publications/00394/) and a Status Report

(http://wdfw.wa.gov/publications/01521/), and it prepares annual reports to update population and habitat information for the species. The DFW also coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats. Additionally, the use of body-gripping traps (foot-hold, conibear, snares, etc.) for trapping other furbearers is prohibited in Washington (except for damage control or nuisance wildlife, which requires special permits). This avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

Unit 5: GYA (Southwestern Montana and Northwestern Wyoming) - See Unit 3, above, for summary of Montana's special trapping regulations to minimize incidental take of lynx. Lynx in Wyoming were offered full protection from trapping and hunting beginning in 1973, and they are designated by the State as a species of greatest conservation need (ILBT 2013, p. 57). The Wyoming Game and Fish Department (WGFD) also participates in the CITES Export Program for bobcats.

Unit 6: Western Colorado - Lynx harvest was prohibited in Colorado in 1970 and the lynx was listed as endangered in the State in 1973. Colorado participates in the CITES Export Program for bobcats, provides information to trappers and hunters on how to distinguish between lynx and bobcats, and requires immediate release of uninjured incidentally trapped lynx as well as reporting of any (uninjured, injured, or killed) incidentally trapped lynx (CPW 2015b, pp. 6-7). Colorado law prohibits the use of foothold or conibear traps and snares for trapping, which avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

State Forest Management Regulations - Timber harvest and other forest management activities on State and private lands are governed by State regulations. Because these activities have the potential for beneficial, benign, or adverse impacts to lynx habitat depending on methods, implementation, and conservation measures, State forestry regulations may influence lynx populations, particularly where substantial amounts of lynx habitat occur on State and private lands. Below, we provide an overview of the forest management regulations in the SSA geographic units and briefly discuss their potential influences on lynx habitat. Additional details on the current and likely future influences of these regulations on lynx populations are provided below in chapters 4 and 5, particularly for the Maine and Minnesota units, where State and private lands constitute the majority of lynx habitats.

Unit 1: Northern Maine - State and private lands constitute 7 percent and 92 percent, respectively, of this SSA unit, with the vast majority of private lands managed for commercial timber production. As described above in section 2.3.2.2 and in more detail below in sections 4.1.1 and 5.1.1, the current abundance of lynx in northern Maine is attr butable to the landscape-scale clear-cutting that occurred on private timber lands in the 1970s and 1980s in response to an extensive spruce budworm outbreak, which resulted in the recent unnaturally large amount of young (15 to 35 years post-harvest) regenerating forest in prime hare habitat condition. The amount and distribution of this post-clear-cut excellent hare habitat likely peaked in the late 1990s, when 20-25 percent of the forest in Maine was in an early regeneration stage - 3 to 8 times higher than historic conditions, when only 3-7 percent of stands were likely in such condition at any given time (68 FR 40094). Current timber harvest and management on State

and private lands in Maine are governed by the Maine Forest Practices Act of 1989 and administered by the Maine Forest Service within the Department of Agriculture, Conservation & Forestry to regulate the size, arrangement, regeneration, and management of clearcuts (MEDACF 2014, pp. 42-45). Under the Act, small (up to 250 acre) clear-cuts are still permitted, but require special permits. Because of this regulatory burden, the extensive clear-cutting of the past has largely been replaced by partial harvest techniques that are unlikely to maintain the current unnaturally high amount and distribution of high-quality hare habitat. The consequences of this shift in forest management on Maine's current lynx population, which is also much larger than was likely possible under the natural historic disturbance regime, are discussed below in sections 4.1.1 and 5.1.1, along with other programs that may influence private lands forest management in this unit.

In Maine, there are no long term management agreements in place on private lands to assure management of lynx. In 2006 and 2007, the Natural Resource Conservation Service (NRCS) provided funds to Maine for a pilot Healthy Forest Reserve Program (HFRP) specifically to manage for Canada lynx and American marten. Five landowners enrolled in the program, but one withdrew. The remaining four landowners were provided funding to develop lynx plans on a total of about 630,000 acres (about 10 percent of the critical habitat area). Landowners selected one or two township-sized (23,000 acre) areas within their ownerships to develop and implement a lynx management plan. Thus, about 161,000 acres within the larger area was targeted for managing lynx. All four landowners completed lynx plans using guidelines in the Service's *Canada lynx management guidelines for Maine* (McCollough 2007). NRCS contracts with the landowners last 10 years and will expire in 2016 and 2017. The HFRP described an opportunity for enrollees to apply for Safe Harbor Agreements when their contracts expired, although none have indicated an interest yet in doing so. Management plans were written for a 70-year period so some landowners may continue voluntary lynx management activities. Many private landowners in Maine are enrolled in forest certification programs; the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Both programs require landowners to protect endangered species and their habitats, but there are not specific recommendations pertaining to lynx. About 2.5 million acres in northern Maine is under conservation easement (http://web.colby.edu/stateofmaine2012/state-of-large-landscape-conservation-in-maine/ last accessed 8.18.2016), but easements require management prescriptions or commitments for Canada lynx. To our knowledge, there are no private landowners in Maine who have committed to long-term or permanent protection and creation of lynx habitat according to the Service's lynx management guidelines or LCAS.

State lands include Baxter State Park (~200,000 acres) and the various lots owned and managed by the Maine Bureau of Parks and Lands (MBPL). Most of Baxter State Park is managed as wilderness area, and lynx sightings in the Park are rare because most of the park is mature forest. MBPL integrated resource policy requires that they promote the conservation of federally listed species, but so far no lynx management plans have been developed. Mitigation for Maine Department of Inland Fisheries and Wildlife's incidental take permit for trapping requires management of 6,400 acres of lynx habitat within a 22,000-acre habitat management area on the MBPL's Seboomook Unit for a 15-year period.

Unit 2: Northeastern Minnesota - State and private lands constitute about 36 percent and 16 percent, respectively, of this SSA unit. The Minnesota Department of Natural Resources (MN DNR) Division of Forestry regulates timber harvest and management on State and private lands. Under the Sustainable Forest Resources Act of 1995 (revised most recently in 2014 [MFRC 2014a, p. 1]), the Minnesota Forest Resources Council (MFRC) has developed voluntary guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) that are intended for private and state landowners and include some general recommendations for wildlife including lynx. However, because they are voluntary, the extent to which these guidelines benefit lynx is uncertain (see sections 4.1.2 and 5.1.2 below).

Unit 3: Northwestern Montana/Northeastern Idaho - State and private lands constitute about 4 percent and 8 percent, respectively, of this SSA unit, and almost all are in Montana portion of the unit. The Montana Department of Natural Resources and Conservation (MTDNRC) administers several laws pertaining to forest practices on State and private lands. These laws are intended to protect streamside management zones, reduce fire hazards, and provide BMPs to minimize non-point source water pollution (http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices, accessed July 18, 2016). Although these laws may provide indirect benefits to lynx and other wildlife, they do not include specific measures to conserve or avoid impacts to lynx habitats. However, the MTDNRC and the Service collaborated on a multi-species habitat conservation plan (HCP) for forested State Trust lands that includes a Lynx Conservation Strategy to minimize impacts of forest management activities on lynx and describes conservation commitments that are based on recent information from lynx research in Montana (USFWS 2104, pp. 22-23; 79 FR 54835-54837). This HCP covers about 64 percent of the State lands in this SSA unit, regulates activities primarily associated with commercial forest management to conserve lynx foraging, denning, and connectivity habitats, and includes a 50-year commitment (79 FR 54835-54836). Additional details on this HCP and other programs for conserving lynx habitats on State and private lands in this unit are provided in section 4.1.3 below.

Unit 4: North-central Washington - State and private lands constitute about 8 percent and 0.3 percent, respectively, of this SSA unit.t, and most are State Trust lands in the Loomis State Forest, which accounts for all 426 km^2 (164 mi^2) of State lands in this unit. The Washington Department of Natural Resources (WADNR) administers rules guiding forest practices, such as timber harvests and road building, on State, private, and tribal forests in Washington. The Forest Practices Board, an independent state agency, adopts forest practices rules to protect water quality, fish habitat, other public resources and guide DNR's permitting process for timber harvests and other forest practices statewide. The WADNR developed a Lynx Habitat Management Plan (LHMP) for WDNR-managed lands distributed throughout north-central and northeastern Washington in areas delineated as Lynx Management Zones in the Washington State Lynx Recovery Plan (Stinson 2001; Washington DNR 2006). The WADNR LHMP guides timber harvest and other vegetation management on these lands, including the part of the Loomis State Forest that occurs in this unit, with the goal of creating and preserving quality lynx

habitat through its forest management activities. Additional information on the LHMP are provided in sections 4.1.4 and 5.1.4 below.

Unit 5: GYA - State and private lands constitute about 0.3 percent and just over 2 percent, respectively, of this SSA unit and, combined, likely have little influence on lynx population persistence. Forestry regulations for the Montana portion of this unit (26 percent) are described above. In the Wyoming portion (74 percent of the unit), the Wyoming State Forestry Division is responsible for the management of forested trust land across the state, including timber management and harvest, for long term forest health and productivity. Although the Division's programs may provide some indirect benefits to lynx, they do not include species- or habitat-specific regulations or conservations measures.

Unit 6: Western Colorado - State and private lands constitute about 0.6 percent and over 9 percent, respectively, of this SSA unit. The Colorado Department of Natural Resources and the State Division of Forestry oversee forest management activities on State and private lands in Colorado.

Tr bal Management: Tribal lands encompassed by SSA geographic units include those of the Passamaquoddy Tribe and the Penobscot Indian Nation in Maine (248 km^2 [96 mi^2] in Unit 1), Grand Portage Band of Lake Superior Chippewa in Minnesota (202 km^2 [78 mi^2] in Unit 2), and the Confederated Salish and Kootenai Tribes of the Flathead Nation - Flathead Reservation in Montana (958 km^2 [370 mi^2] in Unit 3). Tr bal management of these lands is expected to benefit lynx and lynx habitats. No tribal lands occur within SSA units 4, 5, or 6.

Unit 1: Northern Maine - Tribal lands represent less than 1 percent of this unit. The Passamaquoddy Tribe's stated environmental mission is "...to protect the environment and conserve natural resources within all Passamaquoddy lands, waters, and the air we share" (Passamaquoddy Tribe 2014, entire). That of the Penobscot Indian Nation Department of Natural Resources is "...to manage, develop and protect the Penobscot Nation's natural resources in a sustainable manner that protects and enhances the cultural integrity of the Tribe" (Penobscot Indian Nation 2014, entire). Hunting, trapping or possessing lynx are prohibited in accordance with the Penobscot Indian Nation Chapter VII Inland Fish and Game Regulations – Section 204 (Penobscot Indian Nation 2012, p. 15).

Unit 2: Northeastern Minnesota - Tribal lands of the Grand Portage Indian Reservation and the Bois Forte Indian Reservation—Vermillion Lake District represent 1 percent of this SSA unit. The Grand Portage Band of Chippewa has been actively working on lynx conservation since 2004. In October 2007, the Band hosted an international conference on lynx research and conservation where more than 50 researchers from the United States and Canada presented results of research on lynx diet, habitat, and management. Additionally, on-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire).

Unit 3: Northwestern Montana/Northeastern Idaho - Tribal lands of the Confederated Salish and Kootenai Tribes of the Flathead Nation, Flathead Reservation represent nearly 4 percent of this SSA unit. The mission statement of the Tribes' Fish, Wildlife, Recreation and Conservation Division is "...to protect and enhance the fish, wildlife, and wildland resources of the Tribes for continued use by the generations of today and tomorrow" (Confederated Salish and Kootenai Tr bes 2014a, entire). An objective of the Tribes' Tribal Wildlife Management Program Plan is to ''. . . develop and implement habitat management guidelines for Canadian lynx in coordination with the Forestry Department as specified in the Forest Management Plan'' (Confederated Salish and Kootenai Tribes. 2014b, p. 5). The Forest Management Plan states that ''Standards for lynx management and habitat protection are set forth in the Canada Lynx Conservation Assessment and Strategy. This strategy guides land management activity in lynx foraging and denning habitat. Lynx occurrence and populations will continue to be monitored on the Reservation'' (Confederated Salish and Kootenai Tribes 2000, p. 285).

In summary, a variety of State wildlife and forestry regulations and conservation efforts, along with Tr bal resource management objectives, influence activities in lynx habitats across the range of the DPS. While many of these clearly benefit lynx habitats and likely contribute to the persistence of resident populations, uncertainty remains regarding the effectiveness of some regulations and voluntary programs or measures in maintaining or restoring lynx habitats. This may be especially important with regard to timber management regulations and programs on private lands, which constitute the majority of lands in the Northern Maine geographic unit and a substantial amount of the Northeastern Minnesota unit.

3.2 Climate Change

In 2014, the International Panel on Climate Change (IPCC) released its Fifth Assessment Report, which represents the current scientific consensus on global and regional climate change and the best scientific data available in this rapidly changing field. The Fifth Assessment Report largely reaffirms the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere (IPCC 2014a, entire).

''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat

fragmentation) (IPCC 2007a, pp. 8–14, 18–19). In our analyses, we weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

The IPCC's Fifth Assessment Report concludes that the strongest and most comprehensive evidence of the impacts of climate change is in natural systems, where many species have responded by shifting their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC 2014a, p. 4). The report also concludes that projected climate change during and beyond the 21st Century will increase extinction risk for many terrestrial and freshwater species (IPCC 2014a, pp. 14–15). In North America, observed impacts attributable to climate change that may affect lynx habitats and distr bution include upslope and northward shifts in species distributions across multiple taxa, and increased wildfire activity, fire frequency and duration in boreal and subarctic conifer forests of Canada and the western U.S. (IPCC 2014a, p. 31).

At the time of listing, the Service determined there was no evidence to support global warming as a threat to lynx (65 FR 16068-16069). In the 2003 remanded determination, we concluded that the best information available at that time regarding the potential impact of climate change on lynx (warming leading to long-term reductions in snow depths needed to support lynx in the eastern U.S. and eastern Canada south of the St. Lawrence Seaway; Hoving 2001, pp. 72-75) was speculative and did not demonstrate a threat to lynx (68 FR 40083, 40098). In the 2005 recovery outline for the DPS, the Service acknowledged that continued climate warming was l kely to negatively affect the boreal forest ecosystem for which lynx are highly adapted, eventually causing it to recede north and/or to higher, colder elevations, potentially resulting in a substantial reduction or even elimination of lynx habitats from the contiguous U.S. (USFWS 2005, pp. 11, 14). In the 2009 critical habitat rule, the Service acknowledged that new science concerning climate change was available, and that climate change may pose a risk to the future conservation of lynx (74 FR 8617, 8621). In the 2014 revised critical habitat rule, we concluded that recent information on regional climate changes and potential effects to lynx habitat (e.g., Knowles *et al.* 2006, pp. 4545–4559; Carroll 2007, pp. 1098–1102; Danby and Hik 2007, pp. 358–359; Gonzalez *et al.* 2007, entire; Iverson *et al.* 2008, pp. 390–400; Beckage *et al.* 2008, entire; Burns *et al.* 2009, p. 31; Johnston *et al.* 2012, pp. 6–13) suggested that climate change is likely to be a significant issue of concern for the future conservation of the lynx DPS (79 FR 54811). Specifically, climate models project reductions in the extent of boreal forest habitats and snow conditions needed to support lynx throughout the DPS, with both features modeled to migrate to higher elevations (in locations where this is possible) and northward in latitude. This would result in fewer, smaller, and more fragmented and isolated areas capable of supporting resident lynx and, therefore, smaller and more isolated lynx populations that would likely be more vulnerable to stochastic environmental and demographic events (79 FR 54811). Climate change also may have synergistic effects with other stressors (e.g., forest insect outbreaks and wildfire frequency, size, and intensity) that could further reduce and isolate lynx populations within the DPS and reduce connectivity to lynx in Canada.

Lynx biologists identify climate change as the most important and overarching factor influencing resiliency of the DPS (Lynx SSA Team 2016, pp. 14, 17, 19, 21-22, 35-47, 50, 53-57; ILBT

2013, pp. 43, 48, 53, 55, 63, 66, 69-71, 98). Climate change is likely to be exacerbated at the southern edge of the range where habitat and snow conditions are patchy and becoming increasingly marginal for the continued existence of lynx (Gonzales *et al.* 2007, p. 8). Across North America, a significant increase in proportion of winter precipitation falling as rain rather than snow has resulted in reduced persistence of the winter snowpack (Dyer and Mote 2006, entire), increased snow density (Hodgkins and Dudley 2006, entire), and decrease in the extent of deeper snowpacks (Dyer and Mote 2006 p. 1, Brown 2000, pp. 2347-2354). Climate change models suggest that future snow cover in the contiguous U.S. will be further reduced in extent and distr bution (McKelvey *et al.* 2011, pp. 2892-2896).

Warming and more frequent winter thaws are contributing to changes in snowpack structure, namely replacing deep, fluffy snow with harder, crustier snow, with these conditions occurring at higher latitudes (Callaghan *et al.* 2011, entire) and higher elevations in the Rockies (Abatzoglou 2011, pp. 1138-1141). The frequency of warm spells is correlated to the hardness of the snow surface, sinking depth, and the hunting efficiency of lynx (Stenseth *et al.* 2004, p. 10633). As the climate warms, winter temperatures are rising above freezing more often. This results in more rain on snow events and winter thaws that change the structure of the snowpack; larger grain size, basal ice layers, depth hoar (weak layers in the snowpack), and slip planes (crusts and ice layers within the snowpack) (Callaghan *et al.* 2011, p. 23). Hard snow surfaces (crust) and other structure in the snowpack are believed to reduce the competitive advantage of lynx over bobcats and other mesocarnivore competitors and predators.

Although it is believed that high elevation areas in the West may provide refugia for lynx (Lynx SSA Team 2016, p. 45), these areas will also be affected. Mountainous regions in the western U.S. have historically been strongly snow dominated from November through March. By 2050, the length of snowfall-conducive temperatures over many western mountain ranges will be reduced from approximately five (November–March) to approximately three (December-February) months of the year (Klos *et al.* 2014, p. 4566). Many relatively large areas that contain lower relief, mid-elevation mountain ranges will likely shift relatively quickly into new precipitation phase regimes (e.g., the Northern Rockies, North Cascades)(Klos *et al.* 2014, p. 4566). The interior northwestern U.S. shows a greater sensitivity of its strongly snow-dominated areas to warming because much of the region is characterized by relatively warm winter temperatures and by mainly mid-elevation mountain ranges. The climatic rain-snow transition zone will move up in altitude and latitude.

It is possible that in high elevation areas of DPS in the West, snow conditions suitable for lynx may move up slope at a faster rate than boreal forest habitat will migrate, providing a mismatch of these important habitat elements for lynx. During prehistoric periods of warmer climate, the alpine treeline ecotone (upper elevation of lynx boreal habitat) and deciduous-boreal forest ecotone (lower elevation of lynx boreal habitat) have readily moved upslope in both the northern (Kearney and Luckman 1983) and southern Rockies (Legg and Baker 1980). Boreal treelines in Scandinavia moved upslope an average of 40 m (but up to 100 m) during a recent 50-year period of warming (Kullman 1990). However, despite recent warming, the alpine treeline in North America has thus far remained relatively static (Butler *et al.* 1994). Upslope migration of

the treeline of boreal forest may be limited by high winds, desiccation, and soil depth not conducive to colonization by conifers and will occur either gradually or as a series of scattered, rapid advances as thresholds are crossed (Kupfer and Cairns 1996, p. 259-261). At lower elevations, the upslope movement of the deciduous-boreal ecotone is limited by an isocline of excessively cold winter temperatures (generally -40C), moisture (cloud, fog line), and acidic soils (Kupfer and Cairns 1996, p. 263-264). The rate that boreal forest will retreat upslope is highly speculative depending on how climate change will affect complex moisture and temperature regimes, and there could be a lag time before these community types move up slope (Kupfer and Cairns 1996, p. 268). In the Yukon, upslope migration of spruce-fir seemed to be triggered by climate thresholds and was characterized by slow, gradual change followed by rapid advances (Danby and Hik 2007, p. 361). However, in Vermont, the northern hardwood-boreal ecotone moved upslope 91 to 119 m between 1962 and 2005 consistent with rapidly increasing cloud ceilings in the Northeast, which is believed to be closely associated with this ecotone transition (Beckage *et al.* 2008, pp. 4200-4201).

In contrast, there have been no lag time or thresholds slowing changes in the precipitation and snow regime. Much of the Rockies have already experienced declines in spring snowpack in response to climate change, especially since midcentury, despite increases in winter precipitation in many places (Mote *et al.* 2005, entire; Scalzitti *et al.* 2016, pp. 5367-5368). Some mountainous regions are warming at a faster rate than global land averages (Rangwalla and Miller 2012, entire). It is likely that the losses in snowpack observed to date will continue and even accelerate (Hamlet and Lettenmaier 1999; Payne *et al.* 2004), with faster losses in milder climates like the Cascades and the slowest losses in the high peaks of the northern Rockies and southern Sierras. For every 1 °C increase in temperature, snowline increases about 150 m in elevation (Beniston 2016, p. 106). By 2100, the altitude above which it snows and below which it rains will climb as much as 800 feet in the Colorado Rockies, by 1,400 feet in the Rockies of Idaho and Wyoming, and the snow line will rise by an average of 950 feet across six Western mountain regions if greenhouse gas emissions continue at the current rate (Scalzitti *et al.* 2016, p. 1564). Thus, it is possible that boreal forest will persist for a while, but deep, fluffy snow conditions will retreat upslope and preclude the use of boreal habitat by lynx and instead favor competitors such as bobcats.

The effects of climate warming are already occurring and have accelerated over the past three to four decades (Hansen *et al.* 2006, entire). Globally, greenhouse gas emissions are increasing and tracking levels predicted by models for high emissions scenarios (e.g., RCP8.5) (Peters *et al.* 2013; Friedlingstein *et al.* 2014, p. 709, 712; Fuss *et al.* 2014, p. 851; IPCC 2013, p. 180, 187-189). Analysis of paleoclimate indicates 20th century warming is likely to have been the largest of any century within the last 1000 years (Folland *et al.* 2001, pp. 99-101). These changes are predicted to continue and accelerate under future climate scenarios (Hall and Fagre 2003, Fig. 7). The range of warming projected over this century runs from 3.6 °F (2 °C) to 10.8 °F (6 °C) for North America, with warming higher than this average in areas that are inland, northerly, or mountainous.

Climate change is manifested in different ways throughout the northern contiguous United States and the lynx DPS. To date, the observed and predicted increases in surface temperatures have been greatest in the northern Rockies and Northeast (much of the lynx DPS) than elsewhere in the contiguous United States (IPCC 2014, pp. 12, 61, Workshop Report 2016, pp. 14-15). Climate history and projections from regional climate models for regions associated with the lynx DPS units corroborate global models, and indicate that both eastern and western North America, including all portions of the lynx DPS, have warmed in the last century and are l kely to warm 1.8 °F (1 °C) to 5.4 °F (3 °C) by the year 2050 (IPCC 2007b, p. 889). For example, in the Northern Rocky Mountains at Glacier National Park, mean summer temperatures have increased 3.0 °F (1.66 °C) between 1910 and 1980 (Hall and Fagre 2003, pp. 134–137) resulting in lower snowpack, earlier spring melt, and distr butional shifts in vegetation (Hall and Fagre 2003, pp. 138–139; Fagre 2005, pp. 4–9).

Climate change is diminishing snow conditions (reduced depth, quality, persistence) considerably throughout the DPS. The strong warming in recent decades corresponded to a large decline in snow cover in North America, particularly in the mountains of the western U.S. (Mote *et al.* 2005, p. 47-48). In most mountain ranges, relative declines vary from minimal at ridgetop to substantial at snow line. Temperature has increased more in the winter than summer (Knowles *et al.* 2006), which has increased the amount of winter precipitation falling as rain instead of snow throughout the DPS (Feng and Hu 2007, entire; Knowles *et al.* 2006, entire, Huntington *et al.* 2004, entire). The rate of decline in the snowpack of the northern Rockies is unprecedented in the last 1000 years (Pederson *et al.* 2011, entire). An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13).

Climate change is expected to substantially reduce the amount and quality of lynx habitat in the contiguous U.S., with patches of high-quality boreal and subalpine forest habitat becoming smaller, more fragmented, and more isolated (Carroll 2007, pp. 1099–1100; Johnston *et al.* 2012, p. 11). Various forms of snow compaction and structure within the snowpack (see above) give a competitive advantage to bobcats and other predators/competitors with higher foot loading that would normally have difficulty traveling and hunting efficiently in deep, fluffy snow conditions (Murray and Boutin 1991, Murray *et al.* 1994, Kolbe *et al.* 2010). Remaining lynx populations would l kely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103). These trends indicate the range of the lynx in the DPS is likely to contract as a direct result of climate change. Because of climate change and other stressors, lynx biologists believed that only one to three of the six units may persist to the end of the century (Lynx SSA Team 2016, p. 48).

Near-term effects of climate warming on lynx are more certain than long-term effects. Lynx experts anticipate a downward trend for the probability of persistence of lynx in all six geographic units primarily because of the effects of climate warming (Lynx SSA Team 2016, pp. 35-47). The rates of change and magnitude of effects of climate warming is difficult to predict. Climate change is anticipated to affect each unit differently as summarized below.

Climate change is affecting many of the requirements necessary for the continued existence of lynx in the DPS. Climate warming will continue to stress populations into the foreseeable future. Direct effects to lynx, hares, and their habitat that are occurring or can be reasonably anticipated include 1) range contraction, 2) reduction in the periodicity and amplitude of the hare cycle, 3) reduction in snow conditions necessary to give lynx a competitive advantage, 4) reduction in hare habitat quality and populations, 5) reduction in the amount of lynx and hare habitat in the U.S., 6) changes in the frequency and pattern of disturbance events, 7) introduction of disease and parasites, and 8) reduced gene flow. Synergistic effects between these factors and other stressors (e.g., forest management, trapping, development) may intensify their effects (Carroll 2007). Diminished snow, increasing drought and fire, and increased forest pests and disease are believed to currently be the most important stressors for lynx in the DPS, but it is possible that other pathways are, or may become, equally important. Over the next decades, southern lynx populations will continue to be affected by climate change and associated shifts in habitat, prey base, and competition. The extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in the contiguous U.S. (Murray *et al.* 2008).

Range Contraction in the DPS - In response to climate change, lynx range in the DPS is expected to contract from boreal habitat shifting to higher elevation (Danby and H k 2007, pp. 360-362) and northward shifts in latitudinal distribution of boreal habitat and snow conditions (Sturm *et al.* 2001, pp. 342-342; Gonzales *et al.* 2010, pp. 761-766; Koen *et al.* 2015. p. 528; ILBT 2013, p. 69). For example, lynx distribution in southeastern Ontario has shifted northward >175 km over the past 40 years (Koen *et al.* 2014, pp. 757-758). Habitat patches will become smaller, more fragmented and isolated (Carroll 2007, pp. 1099-1100; Johnston *et al.* 2012, p. 11), bobcat distribution will expand northward (see below), and lynx will become more vulnerable to stochastic and environmental and demographic effects because of smaller population sizes and increased isolation.

Reduction in Periodicity and Amplitude of the Hare Cycle - Climate change influences ecological processes by altering large-scale climate systems such as the North Atlantic Oscillation, Southern Oscillation, Pacific North American Index, and North Pacific Index which, in turn, affect patterns of temperature and snow in North America (Stenseth *et al.* 2003, entire). Climate change-induced disruptions are believed to have caused the collapse of cycles in voles, lemmings, and snowshoe hares (Ims *et al.* 2008, p. 81; Cornulier *et al.* 2013, entire; Krebs *et al.* 2010, pp. 484-488). The geographical borders between cyclic and noncyclic populations are shifting, and the spatial extents of regions that have cycles are shrinking. The collapse of cycles in herbivores with high-amplitude population cycles also would imply collapses of important ecosystem functions such as pulsed flows of resources and disturbances throughout the

ecosystem, including declines in predator communities (Schmitz *et al.* 2003, p. 1202; Ims *et al.* 2008, p. 85). A common denominator of cycles that exhibit spatial gradients, such as the more pronounced snowshoe hare cycles in the northern part of its North American range, is that the cycles seem to fade as winters become shorter (Ims *et al.* 2008, p. 81).

Changes in large-scale climate systems have already influenced the climate and snow conditions throughout the geographic range of the lynx in North America (Stenseth *et al.* 1999, entire; Krebs *et al.* 2001a, p. 34; Brown 2000, pp. 2347-2354). Yan *et al.* 2013 (p. 3269) provide the first evidence of the negative effects of climate warming on hare-lynx cycles in Canada. The authors concluded that climate forcing is not only essential in producing sustained cycles, but is also essential in modifying the cycle intervals (Yan *et al.* 2013, p. 3269). Collapses in lynx fur harvests in Canada beginning in the mid-1980s may be linked to warming (Yan *et al.* 2013, p. 3269). With more pronounced troughs in hare abundance cycles, lynx populations will decline (Hone *et al.* 2011, p. 424). Diminished lynx populations in the core of the range in Canada is a concern because most of the populations of lynx in the DPS are believed to be dependent on periodic immigration from Canada for demographic persistence and genetic stability (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789, 68 FR 40091, 40097-40100). If diminished amplitude of the hare cycle in Canada continues, it will likely translate into a reduced potential for lynx to expand into new or unoccupied habitat in Canada or the adjoining U.S. (ILBT 2013, p. 69).

Reduction in Snow Conditions that are Necessary to Provide Lynx a Competitive Advantage - Climate-induced changes in snow depth and quality are critical because they reduce the extent of deep, fluffy snow habitat available to lynx (Knowles *et al.* 2006, p. 4557; Carroll 2007, p. 1103; McKelvey *et al.* 2011, pp. 2893-2895; Lynx BioTeam 2012 p. 69; Gonzales *et al.* 2007, pp. 7-8). Across their worldwide distribution, lynx rely on deep, powdery and persistent snow because they restrict potential lynx competitors such as bobcat or coyote and predators such as fishers and cougars from effectively encroaching on or hunting hares in winter lynx habitat (Peers *et al.* 2016, entire; 79 FR 54809).

Warmer winter temperatures are reducing snowpack in all portions of the lynx DPS through a combination of a higher proportion of precipitation falling as rain and higher rates of snowmelt during winter (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Hoving 2001, pp. 73–75; Mote 2003, p. 3–1; Christensen *et al.* 2004, p.347; Knowles *et al.* 2006, pp. 4548–4549). These trends are expected to continue with future climate warming (Hamlet and Lettenmaier 1999, p. 1611; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 48; IPCC 2007b, p. 850). The IPCC (2007b, p. 850) concludes that ‘‘snow season length and snow depth are very likely to decrease in most of North America except in the northernmost part of Canada where maximum snow depth is likely to increase.’’ Shifts in the timing of the initiation of spring runoff toward earlier dates in western North America are also well documented (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Cayan *et al.* 2001, pp. 409–410; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 41; Knowles *et al.* 2006, p. 4554). In addition, a feedback (albedo) effect is accelerating the rate of loss of snow cover because of the reflective

nature of snow and the relative heat-absorbing properties of non-snow-covered ground. This feedback effect causes the greatest warming to occur at the interface of snow-covered and exposed areas, increasing the rate at which melting occurs in spring (Groisman *et al.* 1994a, pp. 1637–1648; Groisman *et al.* 1994b, pp. 198–200). This effect has led to the average date of peak snowmelt to shift 3 weeks earlier in spring in the Intermountain West (Fagre 2005, p. 4). This albedo effect is further exacerbated by atmospheric soot and desert dust on snow ((Qian *et al.* 2009, entire; Painter *et al.* 2007, entire) and fire-darkened landscapes (Amiro *et al.* 2006, pp. 47-49). Snow accumulation and duration are expected to decline generally in the geographic areas that contain the central and eastern portion of the lynx DPS (IPCC 2007c, p. 891; Burns *et al.* 2009, p. 31). Because lynx require prolonged periods of deep fluffy snow, current habitats that lose this feature would decline in value for lynx (Hoving 2001, p. 73; Carroll 2007, p. 1092; Gonzalez *et al.* 2007, entire).

Reduced snow depth and duration may reduce lynx's competitive advantage over bobcats, which have similar ecology to lynx but are not as well-adapted to hunting hares in deep fluffy snow (Hoving 2001, pp. 23–24; Carroll 2007, p. 1102; ILBT 2013, pp. 69, 71). The bobcat is the closest related species to lynx in North America, and it outcompetes or displaces lynx wherever the two species overlap, at both broad (Peers *et al.* 2016, entire) and local (Parker *et al.* 1983, Robinson 2006, pp. 120-129) geographic scales. In areas where they do overlap, lynx are subjected to niche displacement to habitats of inferior quality, which probably limits lynx survival and productivity at the southern edge of their range (Peers *et al.* 2016, entire; Robinson 2006, pp. 120). Snow depth likely acts as a mediator of competition between the two species. Bobcats have a higher foot loading than lynx, are unable to hunt hares successfully in areas with deep, soft snow (Krohn *et al.* 2005, pp. 122-129, Hoving *et al.* 2005, entire), and experience high mortality in deep snow winters (Litvaitis *et al.* 1986, p. 116). Lynx have a low foot loading and long legs (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, pp. 122-129) that gives them a competitive advantage over bobcats in deep, fluffy snow conditions. This has important implications for lynx persistence and range distribution at the southern edge of their range considering the current and projected changes in snow cover, stable or increasing bobcat populations in the DPS (Roberts and Crimmins 2010, p. 170), and the predicted northward expansion of bobcats into areas currently occupied by lynx (Lavoie *et al.* 2009, pp. 873-874; Roberts and Crimmins 2010, p. 172; Anderson and Lovallo 2003, p. 758).

Buskirk *et al.* (2000a, entire) descr bed exploitation (competition for food) and interference (avoidance) competition from bobcats and other species that may compete with lynx. Exploitation competition could contribute to lynx starvation and reduced recruitment. Of several predators examined (raptors, coyote, gray wolf, cougar, bobcat, and wolverine), coyotes were deemed the most likely to pose local or regionally important exploitation impacts to lynx. Coyotes, bobcats, and cougars are possibly capable of imparting interference competition effects on lynx. Interference would be most probable during summer and during winter in areas lacking deep, unconsolidated snow (ILBT 2013, p. 36). Cougars are also predators of lynx in the West (ILBT 2013, p. 35), but, like bobcats, cougars also have high foot loading, which limits their efficiency in deep, fluffy snow (Buskirk *et al.* 2000a, p. 90). Fishers are predators of lynx in

Maine (Vashon *et al.* 2012), but their distribution and movements in winter are also limited by deep, unconsolidated snow (Krohn *et al.* 2004, entire).

The effects of lynx-bobcat hybridization on lynx populations in the DPS are uncertain. Bobcats have hybridized with lynx in Minnesota, Maine, and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where low topographic relief and variability in winter severity may allow more interaction between the two species during the breeding season (ILBT 2013, p. 34). Hybrids were capable of reproducing successfully (Homyack *et al.* 2008, p. 507). The hybridization rate is currently low between the species (0.24 percent) but could increase as bobcat populations move north with climate change (Murray *et al.* 2007, p. 1465; Koen *et al.* 2015, p. 528).

Reductions in Hare Populations - In addition to affecting the synchronicity and amplitude of hare cycles, climate change will likely affect hare populations in several different ways, especially at the southern extent of the range. Changing snow conditions may influence lynx hunting behavior and effectiveness. For example, hard-packed snow is reported to be associated with a higher kill rate of hares by lynx and coyotes than soft snow (Stenseth *et al.* 2004, p. 10633, Buskirk *et al.* 2000, p. 94). The higher kill rate could generate a numeric response by lynx and other hare predators (Hone *et al.* 2011, p. 420) that could drive hare populations to lower levels (Stenseth *et al.* 2004, p. 10633). Predator communities are more diverse at the southern part of the lynx range than in central Canada (Murray *et al.* 2008, pp. 1464-1465). The diverse predator community could explain why hare populations have declined and seem to remain low in Maine (Scott 2009, p. 43). Climate change will cause increased annual precipitation, periods of drought and extreme precipitation, and hotter summers across the northern tier of U. S. (i.e., throughout the DPS) in eastern North America (Jacobson *et al.* 2009, pp. 14-15, Romero-Lankao 2014, pp. 1452-1456). Increased precipitation may reduce hare numbers because the second litters of snowshoe hares have lower survival in wet summers (Meslow and Keith 1971, entire). However, because hares have two to four litters per summer, there is opportunity for compensatory survival of later litters if one is affected by weather (Krebs *et al.* 2014, p. 1043). Decreased hare survival may also be expected during prolonged hot, dry summer conditions. For example, hare densities in the GYA are believed to be low, in part, because of the dry conditions there (Hodges *et al.* 2009, p. XX). In dry western forests like those in the GYA, increased precipitation may result in more herbaceous forage and cover, which may promote hare survival and reproduction (Ivan *et al.* 2014, p. 590). Thus, climate change may have both positive and negative effects on hares.

Finally, the shorter duration and diminished snow cover in the DPS is causing an increasingly pronounced mismatch in the phenology of hare pelage change that may reduce hare survival (Zimova *et al.* 2013, entire; Mills *et al.* 2013, entire; 2014, entire). Diminished snow duration by as much as 8 weeks by the end of the century could have population-level effects on hares at the southern edge of their range. Hares exhibit plasticity in the rate at which they can molt from white to brown in the spring, but not in the initiation date of color change or the fall transition from brown to white (Mills *et al.* 2013, pp. 7362-7363). Hares do not seem to compensate for mismatched pelage by changing their behavior related to concealment, thus predisposing them

to predation (Mills *et al.* 2014, entire). There is wide variability in the timing of pelage change by individual hares within populations, and “mismatched” hares experience increased mortality rates (Zimova *et al.* 2016, p. 302). Under high emission scenarios, this could lead to an 11 percent decline in hare survival by mid-century and a 23 percent decline by late century. Diminished survival would lead to steep (high emissions) to moderate (medium-low emissions) declines in hare populations (Zimova *et al.* 2016, p. 304). It is also poss ble that this phenological mismatch may dampen hare cycles (Zimova *et al.* 2016, p. 305). Snow patterns have been proposed to potentially play a role in dampening cycles (Cornulier *et al.* 2013, pp. 64-65, Sultaire *et al.* 2016a, entire).

The range of the snowshoe hare is contracting northward in the southern part of its range in the contiguous U. S. because of changing snow conditions and reduced survival because of delayed pelage changes (Diefenbach *et al.* 2016, p. 245; Sultaire *et al.* 2016a, entire). In Wisconsin, snowshoe hare range has been contracting northward an average of 8.7 km per decade and will continue to recede northward with climate change (Sultaire *et al.* 2016a, entire). Loss of snow now contributes more than loss of habitat in determining the range of snowshoe hares in the Great Lakes region (Sultaire *et al.* 2016a, entire).

Reduction in Lynx and Hare Habitats - Climate change will diminish the amount of lynx habitat throughout the DPS by a) reducing the areas where snow conditions give lynx a competitive advantage over bobcats and other species, and b) reducing the amount of spruce-fir habitat required by snowshoe hares. An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Areas of contiguous spring snow cover will become smaller and more isolated throughout the Columbia, Upper Missouri, and Upper Colorado Basins, with greatest losses at the southern periphery, which likely is an indicator of the trajectory of lynx habitat (McKelvey *et al.* 2011). Deteriorating snow conditions caused by climate change is causing range contraction of snowshoe hares and the southern edge of their range (Sultaire *et al.* 2016b, pp. 900-904). Similarly, because of diminishing snow resources, potential lynx habitat is diminishing in the northern Appalachians and small areas in the Canadian Maritime Provinces (Carroll 2007, p. 1093).

Changes in temperature and rainfall patterns are expected to shift the distribution of ecosystems northward and up mountain slopes (McDonald and Brown 1992, pp. 411–412; Danby and Hik 2007, pp. 358–359; IPCC 2007c, pp. 230, 232). As climate changes over a landscape, the ecosystems that support lynx are likely to shift, tracking the change of temperature, but with a time lag depending on the ability of individual plant and animal species to migrate (McDonald and Brown 1992, pp. 413–414; Hall and Fagre 2003, p. 138; Peterson 2003, p. 652). On the basis of the best existing data for 130 tree species in North America and associated climate information, and assuming no limitations to individual tree growth, McKenney *et al.* (2007) predicted that the average range for a given tree species will decrease in size by 12 percent and will shift northward by 700 kilometers (km) during this century. In the contiguous U.S., researchers expect that lynx in mountainous habitat will, to some extent, track climate changes

by using higher elevations on mountain slopes, assuming that vegetation communities supportive of lynx and hare habitats also move upslope (Gonzalez *et al.* 2007, p. 7). Some areas of the DPS (e.g., Maine, Minnesota) lack elevational refugia and, therefore, lynx populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102).

These studies predict lynx and hare habitats—boreal spruce-fir and subalpine forests—and, therefore, lynx distribution, are likely to shift upward in elevation within its currently occupied range and recede northward as temperatures increase (Gonzalez *et al.* 2007, pp. 7, 13–14, 19; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, pp. 26–27, 30–31; Vashon *et al.* 2012, pp. 60, 64; ILBT 2013, p. 69). Lienard *et al.* (2016, p. 7) assessed forests in New England, Northern Great Plains, and higher elevations in the Rockies, including spruce-fir types, as vulnerable to drought-related stress from climate change during the next century. The boreal spruce-fir forests that provide habitat for lynx and snowshoe hares are thought to be limited by summer temperatures and drought (Iverson and Prasad 2001, pp.192–196) and, under a suite of emissions and climate change scenarios, are projected to diminish dramatically or disappear from much of the eastern U.S. (Iverson and Prasad 2001, p. 196; Iverson *et al.* 2008, pp. 390–400). Within the last 20 to 25 years, widespread mortality and reduced growth in red spruce in the Northeast are believed to be linked to climate stress (McLaughlin *et al.* 1987, p. 501, Johnson *et al.* 1988, p. 5373.). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103).

Climate change is disproportionately affecting the boreal forest in Canada, the source of lynx dispersing into the DPS. Arctic and alpine ecosystems are among the most sensitive to climate warming (Diaz and Eischeid 2007, entire). Boreal forests have been identified as a critical "tipping element" of the Earth's climate system and are believed to be more sensitive to drought than other forests (Lenton *et al.* 2008, pp. 1788, 1791). Studies suggest a threshold for boreal forest dieback of ~ 3 °C global warming (Lucht *et al.* 2006, entire, Joos *et al.* 2001, entire). Global temperatures are increasing and snowfall is declining at the fastest rate in higher latitudes within the boreal forest region of Canada and Eurasia (IPCC 2007). Predicted changes to the boreal forest are already occurring, and much of the climate-induced change is occurring faster than originally predicted, suggesting rapid change as opposed to slow linear change (Soja *et al.* 2007, pp. 5-6). General circulation models are in agreement that winter warming across the circumboreal region will be in excess of 40 percent above the global mean (Soja *et al.* 2007, p. 4). Increases in precipitation are expected in the boreal region of Canada, particularly during the winter, but may be offset with increases in summer drought, heat stress and evapotranspiration (Stocks *et al.* 1998, entire). Thus, boreal forests are experiencing rapid increases in tree mortality (Peng *et al.* 2011, entire). Several authors have suggested that grasslands, aspen parklands, and temperate forest will expand northward resulting in decreases in boreal forest (Rizzo and Wiken 1992, p. 50; Starfield and Chapin 1996, entire; Rupp *et al.* 2000, entire), which could further fragment spruce-fir habitat (Iverson *et al.* 2008, p. 404; Tang

and Beckage 2010, pp. 152-156; Simons-Legaard *et al.* 2016, p. 5; Rustad *et al.* 2012, p. 15). Climate change is expected to further fragment boreal forest in southern Canada (Hogg 1994, entire) and would reduce habitat connectivity between lynx populations in the contiguous U. S. and southern Canada.

Changes in the Frequency and Pattern of Disturbance Events – The distr bution, amount, and composition of lynx habitat could be rapidly and dramatically altered by an increasing occurrence and persistence of drought, along with associated outbreaks of insects and pathogens, wind and ice storms, and wildfires (ILBT 2013, p. 70). All of these factors are potentially interrelated with multiple feedback mechanisms, and some have a cascading effect (Dale *et al.* 2001, p. 729). For example, drought can weaken trees, increasing their vulnerability to insects and pathogens. Insects and pathogens can create dead trees or increase fuel loads, potentially increasing the risk and intensity of fire. The boreal forest is a complex and variable system, and these effects are expected to vary in time and space. Climate change may compound these complex interactions into new domains that may be unprecedented and unpredicted (Dale *et al.* 2001, p. 729). These interactions may appear slowly and be difficult to detect because trees live for so long or they be manifested quickly after a catastrophic perturbation to the forest.

Climate change-induced drought and heat stress have already affected temperate and boreal forest (Allen *et al.* 2010, entire), particularly in the West where tree mortality rates have increased rapidly in recent decades (van Mantgem *et al.* 2009, entire). Droughts occur irregularly in forests in eastern North America and the Pacific Northwest, annually at the end of the growing season in forests at the midcontinental prairie–forest border, and annually in summer in western interior dry forests that depend on winter precipitation (Dale *et al.* 2001, p. 727). Increase in growing-season temperature could increase evaporative demand, triggering moisture stress. Under several climate scenarios, future increases in drought stress are expected in the Southern Rockies and parts of the Northwest (Dale *et al.* 2001, p. 727). The Great Lakes region and parts of the Northwest could experience drought stress within two decades, even though these regions may become wetter in later decades (Dale *et al.* 2001, p. 727).

The frequency of wildfire is increasing in boreal forests of North America. Extended fire seasons and increases in the total area burned are anticipated in the western U.S. with continued climate warming (McKenzie *et al.* 2004). Evaluating wildfire patterns in the western U.S. from 1970-2004, Westerling *et al.* (2006, entire) found rapid and dramatic increases in the frequency of large fires, wildfire durations, and the length of the wildfire season beginning in the mid-1980s. Mesic, middle- and high-elevation forest types (such as lodgepole pine and spruce-fir) in the northern Rocky Mountains experienced the greatest increases. Increased spring and summer temperatures and an earlier spring snowmelt strongly influenced large wildfires, suggesting that climate is the primary driver of these changes rather than fire exclusion (suppression), which appears to have had little impact on natural fire regimes of these higher-elevation forest types in this area ILBT 2013, p. 70).. In contrast, climate change is increasing precipitation in boreal forest regions of eastern North America, which has reduced wildfire frequency (Bergeron *et al.*

2001, p. 388). Under multiple climate scenarios, large increases in fire frequency are expected for boreal forest in central and western Canada, and reduced frequency in eastern Canada - a situation that reflects past Paleoclimates that were warmer than the present (Flannigan *et al.* 2001, pp. 860-862). Increased fire frequency at the grassland – aspen parkland – boreal forest transition in western Canada may hasten the conversion of boreal forest to aspen parkland and aspen parkland to grassland (Flannigan *et al.* 2001, p. 860-861), which could affect connectivity and gene flow in lynx populations.

Warmer springs could increase the frequency and duration of wildfires, which in turn could increase vulnerability of surviving trees to bark beetle attack (Westerling *et al.* 2006; ILBT 2013, p. 70). Increasing temperatures and forest homogeneity could create conditions favorable for bark beetle outbreaks that exceed natural disturbance thresholds, perhaps increasing the l kelihood of additional outbreaks in the resulting large areas of even-aged forests (Raffa *et al.* 2008; ILBT 2013, p. 70).

Climate change is dramatically affecting the frequency and intensity of some eruptive boreal forest insect pests and pathogens that affect disturbance patterns in spruce-fir forests. Changes in temperature and precipitation affect herbivore and pathogen survival, reproduction, dispersal, and distr bution. For example, native bark beetles, such as the spruce beetle and mountain pine beetle, are key agents of change in coniferous forest ecosystems in western North America and have recently defoliated millions of hectares – among the largest and most severe in recorded history (Bentz *et al.* 2009). Drought-stressed conifers have increased vulnerability to insect attack. By the end of the century, changes in temperatures across the boreal forests of western North America may cause markedly high probability of outbreak of these species (Bentz *et al.* 2010. pp. 607, 609). In contrast, the range of the spruce budworm, a major pest of spruce-fir ecosystems in eastern North America, is expected to shift northward reducing vulnerability of spruce-fir forests in Maine and Minnesota (Regniere *et al.* 2010, entire). However, widespread clearcutting following the most recent spruce budworm outbreak in Maine was the primary driver creating widespread lynx habitat (Hoving *et al.* 2005, Vashon *et al.* 2012).

Introduced species can affect forests through herbivory, predation, habitat change, competition, alteration of gene pools via hybridization with natives, and disease (as either pathogens or vectors) and can alter the diversity, nutrient cycles, forest succession, and fire frequency and intensity of some ecosystems (Dale *et al.* 2001, p. 727). Climate change will modify the distributions of many introduced species. Currently, there are few exotic species in North American boreal forests. This is l kely because remote areas with little human intervention receive fewer exotic species. However, exotic species could be introduced in the future as boreal systems are increasingly exploited for forest products, mining, energy production, and other natural resources (Schinder and Lee 2010, entire).

Ice storms occur throughout the northern U.S.but are most frequent in the Northeast (Dale *et al.* 2001, p. 728). For example, in January, 1998 a severe ice storm extensively damaged the canopy of many northeastern U.S. and eastern Canadian forests, causing moderate to severe forest damage to over 10 million acres in the Northeast U.S. and southern Quebec (Irland 2000,

entire; Millward and Kraft 2004, entire; Jones and Mulhern 1998, p. 19). Ice storm damage to stands can range from light and patchy to total breakage of all mature stems over extensive areas (Irland 2000, entire). It is uncertain how climate change will affect the frequency, intensity, location, and extent of ice storms; however, atmospheric warming will most likely shift the locations of prevailing ice storms northward.

Introduction of Lynx or Hare Disease and Parasites - Climate change can increase pathogen development and survival rates, disease transmission, and host susceptibility, and some species are predicted to experience more frequent or severe disease impacts with warming while others may be relieved of pathogens (Harvell *et al.* 2002, entire, Harvell *et al.* 2009, entire). Climate change is likely to cause major changes to the geographic range and incidence of insect and tick-borne diseases (Daszak *et al.* 2000).

No apparent climate-influenced parasites or diseases have been identified that would affect Canada lynx or snowshoe hares, but experts believed this was difficult to predict and a possibility (Lynx SSA Team 2016, pp. 27, 37-39). A few pathogens have been documented in lynx in the DPS. For example, plague, a flea-borne disease caused by the bacterium *Yersinia pestis*, which is not native to North America, was reported for the first time in lynx in Colorado (Wild *et al.* 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 lynx released in Colorado between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to *Y. pestis*; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado. Exposure of some lynx to feline parvovirus was detected in six areas in western North America (Montana-Alaska)(Biek *et al.* 2002). *Troglostongylus wilsoni* is a nematode that infects the lungs of lynx and bobcats (Sarmiento 1956, Van Zyll de Jong 1966, Kumar 1974, and Reichard 2004) and was detected in Maine lynx (Vashon *et al.* 2012, p. 24). Lynx with heavy infestations have difficulty breathing and succumb to starvation, as occurred with several Maine lynx (Vashon *et al.* 2012, p. 24).

Reduction in Gene Flow - Koen *et al.* (2014, entire) hypothesized that climate change would create increasingly unsuitable environmental conditions for lynx (e.g., milder winters with reduced snow quality, declining and fragmented boreal forest), which was associated with low genetic diversity and high genetic differentiation at the trailing (southern) edge of the range. Furthermore, high winter temperature, low snow depth, and low proportion of suitable habitat were strongly correlated with neutral genetic diversity, low allelic richness, and high genetic differentiation (Koen *et al.* 2014, p. 757). The authors surmised that genetic structuring in southern lynx populations could be caused by a northward shift in optimal conditions, resulting in isolation and extirpation of lynx populations at the trailing edge of their range or climate-induced changes in the distributions of snowshoe hare or bobcats causing lynx to shift northward. Lynx with the greatest allelic richness were found in areas with the deepest snow in the core of their range in northern Ontario (Koen *et al.* 2014, p. 758). The authors concluded that climate warming has reduced gene flow at the receding (southern) edge of the lynx's range, and that southward gene flow from Canada into threatened U.S. populations is unlikely (Koen *et al.* 2014, p. 760). Stenseth *et al.* (2004, entire) documented population and genetic structuring in the lynx populations east and west of Hudson Bay based on differences in snow conditions on

either side of this divide. This may be explained by the reluctance of lynx to disperse between areas having different snow regimes and snow quality. Snow conditions may be the key factor in the spatial, ecological, and genetic structuring of Canada lynx (Stenseth *et al.* 2014, pp. 10633-10644).

Climate warming may further isolate lynx populations, thus reducing gene flow, by reducing connectivity between populations. For example, gene flow between eastern Canada and Maine lynx populations depends on an ice bridge for dispersal across the St. Lawrence River. Although some lynx currently cross the river, Koen *et al.* (2014, entire) found genetic structuring on either side of the river. Thus, the river already restricts gene flow. Climate-induced deteriorating ice conditions on the St. Lawrence River could further restrict gene flow between lynx populations north and south of the river (Koen *et al.* 2014, p. 528). Between 1969 and 2002 there was a 20 to 40 percent reduction in sea-ice cover during the spring thaw in the Gulf of the St. Lawrence (Johnston *et al.* 2005). Conversely, reduced ice on the St. Lawrence may prevent bobcats from dispersing northward into lynx areas in central Quebec (Koen *et al.* 2014, p. 528).

3.3 Vegetation Management

Forest management occurs across the range of the lynx and can directly affect important habitats and prey. At the time of listing, management activities uninformed by consideration of negative impacts to the species were identified as being of greatest potential concern to lynx conservation (68 FR 40076-40101). Forest management is the most prevalent land use throughout the lynx DPS and can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitat and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Forest management affects stand structure, composition, and arrangement on the landscape, which are important elements of habitat for snowshoe hares and lynx. At the home range scale, lynx throughout the DPS select landscapes having the greatest snowshoe hare densities. In Maine and Minnesota these are young, regenerating spruce-fir forests (Hoving *et al.* 2004, McCann and Moen 2011) and in the West regenerating lodgepole pine (Koehler, Maletzke, Berg *et al.* 2012) and dense mature conifer forest, as well as young stands with dense spruce-fir saplings (Griffin 2004, Squires *et al.* 2010, pp. 1648, 1653–1656; Berg *et al.* 2012). Silvicultural prescriptions and cutting practices in boreal forest types vary widely throughout the lynx DPS depending on the landowner, forest ecology and ecoregion, tree species, site conditions (e.g. moisture, slope, aspect), disturbance regimes (e.g., fire, insect outbreaks), forest policy and regulations, logging equipment, and markets for forest products. Forest management that creates habitat for hares and lynx in one geographic area may not be beneficial to hares and lynx in another.

Nevertheless, snowshoe hares throughout the DPS range respond to one common denominator. Dense understory (horizontal cover) is the most important forest structural characteristics for hares throughout their range (Ferron and Ouellet 1992, Wolfe *et al.* 1982, Litvaitis *et al.* 1985). Dense, horizontal cover provides hares with a source of browse and cover from predation. Softwood (e.g., spruce-fir) has about three times more cover value than hardwoods (Litvaitis *et al.* 1985). Thus, stem density (or stem cover units) and snowshoe hare

density are directly and positively correlated (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Koehler and Brittell 1990, Thomas *et al.* 1997, Hodges 2000a, Mowat *et al.* 2000, Homyack *et al.* 2006, Robinson 2006, Scott 2009, Fuller and Harrison 2013). Forest practices that promote high stem density and dense horizontal cover can increase snowshoe hare densities (Keith and Surrendi 1971; Fox 1978; Conroy *et al.* 1979; Wolff 1980; Parker *et al.* 1983; Livaitis *et al.* 1985; Bailey *et al.* 1986; Monthey 1986; Koehler 1990a, b; Robinson 2006; Fuller *et al.* 2007; Homyack *et al.* 2007; Scott 2009; McCann and Moen 2011). Forest practices that reduce dense understory generally reduce habitat quality for hares and lynx.

Effects of forest practices on snowshoe hare habitats have been studied across the range of the species (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Thomas *et al.* 1997, Homyack *et al.* 2005, Robinson 2006, Griffin and Mills 2007, Scott 2009, Berg 2010, Ivan 2011a, Lewis *et al.* 2011, McCann and Moen 2011). Similarly, the effects of forest management on lynx habitat use, movements, and home range have been investigated by Koehler (1990a), Koehler and Brittell (1990), Fuller *et al.* (2007), Homyack *et al.* (2007), Moen *et al.* (2008), Vashon *et al.* (2008b), Simons (2009), Squires *et al.* (2010), Simons-Legaard *et al.* (2013), Simons-Legaard *et al.* (2016).

Historically, the dominant natural disturbance processes that created young, regenerating conifer forest conducive to hares and lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of northern Maine, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S. After disturbances, forests generally develop through several stages descr bed by Oliver (1980) as “stand initiation,” “stem exclusion,” “understory reinitiation,” and “old growth.” Stand dynamics, particularly within-stand competition for light, nutrients, and space, determine how forests grow and respond to intentional manipulations and natural disturbances (Oliver and Larson 1996). The frequency and severity of disturbances have a large role in determining which species will dominate in a stand after the disturbance event. Snowshoe hare and lynx habitat are created during the stand initiation stage, after the young trees have established and grown tall enough (1-3 meters) to protrude above the snow and provide adequate horizontal cover. During the stem exclusion stage (~10 meters depending on tree species) the tree crowns lift and lower branches self-prune, thus reducing the live horizontal branches providing food and cover for snowshoe hares. In the old growth stage, understory may re-develop (e.g., in forest gaps where mature trees die or fall down) and food and cover may again become available to support snowshoe hares.

Commercial timber management of conifer forests traditionally has been designed to: in very young, regenerating forest to select for desired species (e.g., herbiciding, plantations) and reduce tree density to promote tree growth (e.g., precommercial thinning); in young middle-aged forest to improve growth and vigor of mature trees (e.g., commercial thinning, pruning, thinning from below); and in mature forest to reduce the vulnerability of commercially valuable trees to insects, disease, and fire (e.g., commercial thinning, group selection, fuels reduction). The

culmination of the process (or a forest rotation) is harvesting of forest products. Just as the timing and intensity of a natural disturbance affects the composition of the succeeding forest, the season, climate, machinery, and type of final harvest (e.g., clearcut v. partial harvest) have a large role in determining the species composition and health of the next crop of trees. Timber management practices may mimic natural disturbance processes but often are not an exact ecological substitute. Some practices, such as use of herbicides to suppress hardwood regeneration or plantations do not have an historical analogue. Timber harvest may differ from natural disturbances by:

- Removing most standing biomass from the site, especially larger size classes of trees, and down logs, which alters microsite conditions and nutrient cycling;
- Creating smaller, more dispersed patches and concentrating harvest at lower elevations in mountainous regions and on more nutrient rich soils, resulting in habitat fragmentation;
- Causing soil disturbance and compaction by heavy equipment, which may result in increased water runoff and slower tree growth at the site; or
- Giving a competitive advantage to commercially-valuable tree species and reducing the structural complexity of the forest through the application of harvest, planting, thinning, and herbicide treatments.
- Forest practices often have a smaller footprint on the landscape than widespread fire, insect, or wind damage.

Forest management may (or may not) be compatible with creating or maintaining habitats capable of supporting hares and lynx. Where the objective is to provide snowshoe hare habitat by creating additional early-successional forest conditions, management considerations include selecting areas that are capable of, but not currently providing, dense horizontal cover, designing the appropriate size and shape of treatment units, retaining coarse woody debris, and maintaining high stem densities in regenerated forests (Koehler and Brittell 1990, Homyack *et al.* 2004, Bull *et al.* 2005, Fuller and Harrison 2005, Ivan 2011a).

North America is the world's leading producer and consumer of wood products. Therefore, worldwide trends in forest products markets greatly affect forest management outcomes and thus, the amount and quality of lynx habitat in the DPS. Forest management decisions (e.g., to focus on hardwood or softwood production) can change dramatically in response to unpredictable and changing forest products markets. Globalization of manufacturing and expanded use of electronic media have reduced demand in pulp and paper since the late 1990s, and the collapse of housing construction since 2006 have contributed to declines in U. S. wood product output. Within the northern region of the U. S. (Maine to North Dakota) there has been a considerable decline in terms of employment, mill numbers, wood consumption and forest harvests since 2000 (Woodall *et al.* 2011). As a large amount of this region's forest industry is print paper manufacturing and composite panel production, the rise of electronic media and decline of home construction has precipitated a decade of decline, which only deepened since the recession of 2007-2009. The West, prior to the recession, was a major softwood lumber producing region, and was particularly hard hit by the recession and housing

collapse. Employment dropped by 30 percent or nearly 80,000 workers and annual value of output fell by more than 25 percent (Keegan *et al.* 2011). Under depressed markets, landowners may reduce harvests, which may be to the detriment of lynx in some parts of the DPS (e.g., Maine and Minnesota), and to the benefit of lynx in others (the West).

Markets for softwood products are particularly volatile and depend on demand for paper and housing. Thus, softwood management is affected by economic factors that are difficult to predict. In recent years, the forest products industry throughout the U. S. experienced a downturn in output levels not seen in decades, and employment losses in the hundreds of thousands (Woodall *et al.* 2011, p. 595). Despite depressed markets, one area of increasing interest is bioenergy production. Rising energy costs and growing concerns over global climate change have increased interest in bioenergy production, and the U. S. Energy Independence and Security Act (2007) mandates a five-fold increase in biofuel production (Benjamin *et al.* 2009, p. 125). The wood pellet sector is expected to grow, although woody biomass is typically the lowest value wood commodity sold from the forest. Thus, it is questionable whether wood energy revenues would be enough to sustain forest investments and forest management into the future (Woodall *et al.* 2011, p. 601).

Whereas management of state and federal forest lands have been relatively stable in recent decades, management and ownership of private forest land ownership has been extremely unstable. This has resulted in major shifts in forest management strategies, outcomes, and products. For example, in the last two decades in Maine, where nearly all the lynx critical habitat is on private land, about 23.8 million acres (80 percent) of industrial land ownerships in the "northern forest" (Adirondacks to northern Maine) were sold to a host of financial groups (Hagan *et al.* 2005). These groups have short-term investment goals and different management objectives and have dramatically changed harvest practices. Whereas the previous large industrial landowners focused on the forest land base as a supply for their manufacturing facilities, the new TIMOs and REITs focus on maximizing return on their investment (Jin and Sader 2006, p. 178). Initially, the effects of ownership changes were uncertain (McWilliams *et al.* 2005), but an evaluation of harvesting in the last decade indicates these landowners increased harvest rates, shortened rotation rates, and shifted to managing and harvesting hardwood tree species (Jin and Sader 2006, p. 183-185). On one hand, these trends in Maine private lands management make lynx management commitments more difficult because short-term landowners are not interested in long-term commitments. On the other hand, some easement owners may have an incentive to manage for lynx to meet forest certification requirements.

The extensive sale of private forestlands initiated the growth of conservation easements in this region (deGooyer and Capen 2004, Lilieholm *et al.* 2010). Conservation land as a percentage of Maine's state area increased from less than 5 percent in 1987 to approximately 19 percent by 2012 (Beck *et al.* 2012, p. 15). Conservation easements restrict development but usually do not affect forest management; neither do they typically require management for lynx and other rare species. Some private forestlands were sold to state and federal agencies and conservation interests. For example, in recent years The Nature Conservancy purchased 310,000 acres of

private forestland in Montana and 185,000 acres of private forestland in northern Maine. Lands in conservation ownership have a high probability of being managed to benefit hares and lynx.

Finally, future trends in forest management will be affected by climate change (Irland *et al.* 2003, entire). Many models have been developed to project how U.S. timber production and markets may adapt to climate change (e.g. Burton *et al.* 1998, Joyce *et al.* 1995, Perez-Garcia *et al.* 1997, Sohngen and Mendelsohn 1998). Economic models predict that under climate change, total U.S. timber inventories will increase, timber harvest will increase, and product prices will decrease relative to an assumed stable climate. Some models predict that consumers will gain from climate change while landowners in some regions will lose. The forest industry will adapt to climate change in many ways including using alternate tree species in manufacturing, shifts to geographic regions of the country with economic advantages in timber growth, and increasing forest plantations with new species that are favorably adapted to the new climate and markets. Many strategies have been evaluated to increase the quantity of carbon stored in North American forests (Irland *et al.* 2003) including discontinuing or greatly reducing harvest in some forests to build carbon reserves, increased recycling to reduce use of forest products, converting agricultural lands to forests, and substituting wood products for more energy-intensive products. Increased atmospheric carbon will increase forest growth slightly, except for softwood (Irland *et al.* 2001, p. 757-758). Sawtimber production, which sequesters more carbon, is expected to increase (Irland *et al.* 2001, p. 758). Expanding landscapes with older growth conifer forest to sequester carbon could benefit lynx in the West and be to the detriment of lynx in the East.

Climate change will affect forest-related recreation. Warmer lowland temperatures will attract more people to relatively cooler mountainous and northern forests (Irland *et al.* 2001, p. 759). The ski industry is currently in decline, and climate-induced changes in snowfall will further stress this industry, except for higher elevation western resorts where snowfall is more dependable and where artificial snow is less expensive to make (Irland *et al.* 2001). These climate-induced trends in recreation are anticipated to bring more people into the lynx DPS, which could bring additional social pressures concerning decisions related to forest management (e.g. clearcutting) (Swanson and Loomis 1996). At this time, there are many uncertainties concerning the socioeconomic implications of climate change and adaptation in the northern forests supporting the lynx DPS.

Past and future forest management affects many of the requirements necessary for the continued existence of lynx in the DPS. Forest management is expected to be the predominant land use throughout the DPS into the foreseeable future, and major climate-induced changes in forest industry are anticipated (Irland *et al.* 2001, entire). Beneficial effects of forest management include 1) creating lynx habitat, 2) maintaining an undeveloped landscape conducive to lynx, and 3) long term management planning for lynx (especially on federal lands). Adverse effects to lynx, hares, and their habitat that are occurring or can be reasonably be anticipated include 1) reduced quality of hare habitat in some parts of the DPS, 2) loss and fragmentation of lynx and hare habitat in the U. S., and 3) changes in the frequency and pattern of disturbance events. Synergetic effects between forest management and other stressors (e.g.,

climate change, trapping, development) may intensify their effects (Carroll 2007). Habitat loss and fragmentation are believed to currently be the most important stressors for lynx in the DPS (Fig. X), but it is possible that other pathways for forest management are, or may become, equally important. Hares and lynx will continue to be affected (both positively and negatively) by forest management into the foreseeable future. Forest management stressors primarily affect lynx by lowering landscape hare densities, which in turn reduce lynx reproduction and lower

Reduced Quality of Hare Habitat - Throughout the lynx DPS, some vegetation management practices, especially thinning in young, dense regeneration, reducing overstory canopy in mature multi-story spruce-fir forests (in the West), and partial harvesting (in northern Maine) reduce the quality of boreal forest habitats for snowshoe hares and lynx. This could cause lynx to increase their home ranges, reduce productivity, or in extreme cases to abandon their home range or cause mortality.

Thinning of young, dense sapling stage conifers (precommercial thinning) is a forest management practice used widely throughout the DPS to increase the growth and value of selected trees and to reduce the time to maturity of a stand of trees. Precommercial thinning removes competing trees of the same species or shrubs and trees of other species (Daniel *et al.* 1979; Homyack *et al.* 2005, 2007). Reducing the density of sapling-sized conifers in young regenerating forests to increase the growth of certain selected trees promotes more homogeneous patches and reduces the amount and density of horizontal cover, which is needed to sustain snowshoe hares (Sullivan and Sullivan 1988, Hodges 2000b, Griffin and Mills 2004, Ausband and Baty 2005, Griffin and Mills 2007, Homyack *et al.* 2007, Ellsworth 2009). Hares reach highest densities in stands with stem densities ranging from 4,600–33,210 stems/ha (1,862–13,445 stems/ac)(Wolff 1980, Parker 1984, Litvaitis *et al.* 1985, Monthey 1986, Parker 1986, Koehler 1990a, Griffin 2004, Fuller and Harrison 2005, Robinson 2006, Scott 2009), whereas thinned stands have densities of 2990 (6-foot spacing) to 1,682 (8-foot spacing) stems/ha (Pitt and Lanteigne 2008, p. 593). Precommercial thinning has been shown to reduce hare numbers by as much as 2- and 3-fold (Griffin and Mills 2004, 2007; Homyack *et al.* 2007) because of reduced cover and decreased availability of browse. Griffin and Mills (2007) reported that, if their results were representative, the practice of precommercial thinning could significantly reduce snowshoe hares across the range of lynx.

There are anecdotal examples of precommercially thinned stands that subsequently "filled in" with understory trees. Some have suggested this could be a technique to extend the time that understory trees and low limbs provide the dense horizontal cover that constitutes snowshoe hare habitat. The duration between time of thinning and regrowth to a height providing winter snowshoe hare habitat would likely vary by tree species, each having different regenerative capacities that could be influenced by a variety of local factors (e.g., topographic relief, moisture, and mineral and organic content of the soil; Baumgartner *et al.* 1984, Koch 1996). Bull *et al.* (2005) reported that the slash and coarse woody debris remaining after precommercial thinning provided both forage and cover for snowshoe hares up to a year following treatment. However, Homyack *et al.* (2007) found that snowshoe hare densities were reduced following precommercial thinning for 1–11 years post-thinning. They further suggested that after

precommercial thinning, the stands did not regain the structural complexity in the understory that would be needed to support pre-treatment snowshoe hare densities. At this time, no other data are available to quantify the re-establishment of snowshoe hare habitat and over what time period, or the response by snowshoe hares, as compared with sites that were not precommercially thinned, so this remains an unproven management technique. As an alternative to standard precommercial thinning (i.e., complete thinning resulting in a homogeneous patch), Griffin and Mills (2007) suggested retaining at least 20 percent of the patch in untreated clumps of about ¼ ha (½ ac), which would maintain hare habitat in the short term. However, Lewis *et al.* (2011) found that landscapes with patches of high-quality habitat surrounded by similar vegetation supported more hares than did more fragmented landscapes composed of high-quality patches in a matrix of poorer-quality habitat. Further long-term studies of modified thinning methods are needed.

Because of documented adverse effects of precommercial thinning to snowshoe hares and lynx, in 2007 and 2008 the USFS amended Forest Plans to incorporate management that would conserve lynx, including direction that prohibited precommercial thinning in most lynx foraging habitat (USFS 2007, pp. 8, 11-14, 36; USFS 2008, pp. 6-9, 23-26) . However, precommercial thinning is not regulated on private forest lands throughout the remainder of the DPS.

Uneven-aged management (single tree, partial harvest, and small group selection) practices can be employed in stands where there is a poorly developed understory, but have the potential to produce dense horizontal cover for snowshoe hares. Removal of select large trees can create openings in the canopy that mimic gap dynamics and help to maintain and encourage multistory attr butes within the stand. However, if removal of large trees opens the canopy to the extent that the patch functions as an opening, this may discourage use by lynx (Koehler 1990a, von Kienast 2003, Maletzke 2004, Squires *et al.* 2010). Removal of larger trees from mature multi-story forest stands to reduce competition and increase tree growth or resistance to forest insects may reduce the horizontal cover (e.g., boughs on snow), thus degrading the quality of winter habitat for lynx (Robinson 2006, Koehler *et al.* 2008, Squires *et al.* 2010). Similarly, removing understory trees from mature multi-story forest stands reduces the dense horizontal cover selected by snowshoe hares, and thus reduces winter habitat.

Partial harvesting broadly describes many methods of removing a portion of the overstory trees from a forest stand. Partial harvesting includes selective cuts, shelterwood cuts, and uneven-aged management. Partial harvest may be “light” (e.g., <10 percent of trees removed) to “heavy” (e.g., 90 percent of trees removed). Since passage of the Maine Forest Practices Act in 1989, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine (Sader *et al.* 2003, entire). In recent years, about 425,000 acres of Maine forest are harvested annually and 96 percent of this land is partially harvested (Maine Forest Service 2016? Check). After 17 years of extensive partial harvests, much of the northern Maine landscape has been influenced by this form of forestry, and will continue to be into the future. The popularity of this form of harvesting extends beyond Maine. From the mid-1980s to mid-1990s, partial harvesting comprised 62 percent of the harvest in the U. S., and clearcuts comprised the other 38 percent. Partially harvested stands result in a wide range of

residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006). On average, partially harvested stands supported about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006). Shelterwood cuts, a form of even-aged management, are the exception and have maintained densities similar to regenerating clearcut stands (D. Harrison, U. Maine, unpubl. data). Current hare densities in partially harvested stands in Maine average about 0.4 hares/ha (Simons 2009, p. XXX, check), which is below the landscape hare densities (0.5 hares/ha (Ruggiero *et al.* 2000b, Simons-Legaard *et al.* 2013) needed to support lynx.

In the Great Lakes Geographic Unit, prescr bed burning is used in lynx habitat primarily as a tool to reduce fuels (including from blow-down) and mimic a more natural fire regime in pine forest types (Plate 4.4). In these instances there is a short-term (10–30 years) impact on snowshoe hare habitat. In the western U.S., prescribed fire for ecosystem restoration is most applicable to the dry ponderosa pine and Douglas-fir forests that are not lynx habitat. Because spruce-fir forests are generally composed of thinner-barked trees that are easily killed even with light fire, this technique is not used frequently in most lynx habitat.

Biomass removal for energy production targets the removal of dead trees, logging slash, and small-diameter trees and shrubs. Biomass removal is similar to fuels treatments in reducing cover and habitat for snowshoe hares.

Fuels treatments commonly are designed to remove understory biomass and reduce stem density in forests that are outside their historical range of variability, and to clear fuels adjacent to human developments for safety or to protect investments (Plate 4.3). These types of projects are becoming more common. In the western U.S., projects designed to restore forests to a condition more representative of the historical range of variability are generally targeted to drier, lower-elevation forests affected by fire suppression (Hessburg *et al.* 2005), which are not lynx habitat. Lynx habitats in higher-elevation spruce-fir forests have been less affected by past fire suppression and are mostly within the historical range of variability (Agee 2000). Fuels treatments may be needed to protect human communities and capital improvements by reducing the intensity and rate of spread of a fire, affording control actions with a higher probability of success and providing safer conditions for firefighters. By removing or reducing the understory and ladder fuels to meet those objectives, dense horizontal cover important to snowshoe hares is reduced and habitat value is diminished for hares and lynx.

Loss, Degradation and Fragmentation of Boreal Forest Habitat - Forest management rarely results in conversion of lands to non-forest. In fact, forested landscapes have increased in some parts of the DPS (especially in the Northeast) because of farm abandonment and recolonization by second-growth forest. However, some forms of forest management such as selective harvesting and fire suppression can intentionally (or not) alter tree species composition away from boreal forest types that support snowshoe hare and lynx. Similarly, lack of forest management can alter tree species composition (Trani *et al.* 2001, pp. 415-417). Other stressors, such as insects and climate change, can work in synergy with forest management to reduce boreal forest. For example, in northern New England clearcutting leads to drying of the

forest floor and consequent heavy mortality in spruce and fir regeneration and increased light levels that increase hardwood competition (White and Cogbill in Eagar and Adams 2012, p. 32).

Plantations can convert native forest communities into monocultures of a native or exotic tree species that may lack hardwood browse for snowshoe hare. Cutting rotation can be reduced by half through mechanical site preparation, planting, and suppression of hardwood competition. Conifer stem densities in plantations range from 800-5,000 stems/ha and may support relatively low populations of snowshoe hares because of the initial wide spacing of trees (Bellefeuille *et al.* 2001, p. 44). Hare densities may increase after trees in a plantation reach the sapling stage and branches intermingle at the ground level creating horizontal cover if the lateral branches are not pruned (Parker 1984, p. 163, Parker 1986 p. 160, Roy *et al.* 2010, p. 285). However, the period of time that spruce plantations may support high hare densities in Maine and eastern Canada may be relatively short (10 to 17 years post-harvest) compared to regenerating softwood clearcuts (15-35 years post-harvest)(Simons-Legaard *et al.* 2013, p. 569).

Under certain forest stand conditions, herbicide treatment may have long-term effects on stand composition and structure (MacLean and Morgan 1983, Daggett 2003), thus reducing food, cover, and habitat for hares (Borrecco 1976, Bellefeuille *et al.* 2001, p. 43, Thompson *et al.* 2003 p. 462). Understory deciduous stems were lacking in stands treated with herbicide (Homyack *et al.* 2004). Although herbicide treatments reportedly do not directly affect survival, fecundity, or other demographic parameters of snowshoe hares (Sullivan 1996), treatments have indirect effects on hares via changes in vegetative cover and browse (Homyack *et al.* 2005, p. 10). In Norway, hares use of plantations was reduced up to 10 years after herbicide application (Hjeljord *et al.* 1988).

Fragmentation - Lynx achieve highest densities in >100 km2 landscapes having a high percentage of large, contiguous patches of high quality hare habitat (Simons 2009, Simons-Legaard *et al.* 2013). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges, by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that land-scapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Forest management can fragment and isolate patches of high quality hare habitat (Simons-Legaard *et al.* 2016). In an intensively managed landscape, lynx habitat is described as a shifting mosaic of patches of habitat suitable to support the needs of resident lynx (FR 74(36)). Fragmentation of the naturally patchy pattern of lynx habitat in the contiguous U.S. can affect

lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation from forest management can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. For example, in Maine the proliferation of partial harvesting will actually increase the patches of high quality hare habitat by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6).

Changes in Frequency and Pattern of Disturbance Events - Prior to European settlement, the dominant natural disturbance processes that created early-successional stages within the range of the lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of the Northeast Geographic Unit, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S.

Today, forest management is the predominant form of disturbance in boreal forest types throughout the DPS, but in the West insect outbreak or wildfire are also critical agents of disturbance that influence and interact with forest management. Throughout the DPS, the frequency of harvesting accelerates in response to salvaging insect damaged stands. In some instances, forest management has greatly altered the disturbance regime. For example, the Acadian forest in Maine and eastern Canada was driven by gap dynamics (similar to some parts of the West today) and true stand-replacing disturbances were quite uncommon with recurrent intervals of thousands of years. After several centuries of forest management, stand age structures have become simplified, and commercial timber rotations are a fraction (15 to 40 percent) of the lifespan of boreal tree species (Seymour 2002). Whereas prevalent, these younger even-aged forest stands on the landscape may benefit hares and lynx in Maine, forestry has shifted the species composition of Maine's forest to species favored by frequent harvest disturbance, such as red-maple, paper birch, aspen, and balsam fir.

3.4 Wildland Fire Management

Wildfire is a natural and essential component of boreal and montane forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger *et al.* 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Wildfire creates and maintains lynx habitats by providing periodic vegetation disturbances that result in the spatial and temporal distribution of early-successional forest stands or patches within older stands featuring dense horizontal cover at ground and snow level. These stands/patches provide high-quality hare foraging habitat and typically support high densities of hares, which in turn provide high-quality lynx foraging habitat.

They are generated by (1) high-intensity, stand-replacing fires that result initially in removal of all or most vegetation, followed by regeneration of dense horizontal cover, or (2) low- or moderate-intensity fires that stimulate understory development in older stands without killing all the overstory, resulting in patches of dense horizontal cover within multi-storied stands (Agee 2000, p. 53; Ruediger *et al.* 2000, p. 7-6). These habitats become most favorable for hares and lynx when regenerating conifers grow tall enough to protrude above the snow, providing cover and food for hares throughout the winter (ILBT 2013, pp. 10-12). They remain important as winter foraging habitat, which may be the most limiting habitat for lynx (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 17, 27), until they reach the stem-exclusion structural stage and self-pruning results in the loss of dense horizontal cover above the snow, or until another disturbance resets them to the stand-initiation structural stage (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 1-3; ILBT 2013, p. 27). The length of time to achieve favorable hare and lynx habitat after fire (or other vegetation disturbance) and the duration for which those conditions persist vary across the lynx range depending on soil and vegetation potential, temperature and precipitation patterns, topography, fire intensity, and perhaps other local conditions (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 2-5; ILBT 2013, pp. 27-29, 75). Generally, regenerating forests in the DPS range may begin providing winter hare habitat within 10-20 years after fire or other disturbance, with favorable conditions persisting for 20-30 years after that (Koehler and Aubry 1994, pp. 86-87; Agee 2000, pp. 67-71; Fuller *et al.* 2007, p. 1985; McCann and Moen 2011, p. 515; Vashon *et al.* 2012, p. 15; ILBT 2013, pp. 28-29), although it may take longer, perhaps 35-40 years, for lynx habitat to recover in some parts of the range (e.g., Maletzke *in* Lynx SSA 2016, p. 21).

Fire frequency, size, intensity, and return intervals also vary across the range of the lynx and depend on localized vegetation communities, climatic conditions, and topography (Agee 2000, pp. 47-56; Ruediger *et al.* 2000, p. 4-8; ILBT 2013, pp. 75-76). In lynx habitats, fire intensity is typically high and fire return intervals long but variable, with large areas affected by infrequent stand-replacing fires and, in mixed fire regimes, moderate- or low-intensity fires in the intervals between stand-replacing events (Agee 2000, pp. 49-54; Ruediger *et al.* 2000, pp. 4-8, 7-6). Within the DPS range, fire return intervals in the Great Lakes Region appear similar to those in the core of the lynx's range in the Canadian and Alaskan taiga (roughly 50-150 years), with longer return intervals in Western (150-300 years) and Northeastern (up to 500 years) U.S. forests (Agee 2000, pp. 52-53; ILBT 2013, pp. 75-76). Despite these long intervals, fire is the dominant natural disturbance mechanism in lynx habitats in the DPS range except in the Northeast, where insects and wind are more important (Agee 2000, p. 53).

Current federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI *et al.* 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Ca kin *et al.* 2015, pp. 1-3) which, combined with other land-use practices, dramatically altered fire regimes in some places and created conditions prone to larger and more severe fires (USDI *et al.* 2001, p. 1-2). Because of (1) fire's important role in creating and maintaining high-quality early-successional hare habitat in most lynx habitats in the contiguous

U.S., (2) the potential for fire suppression to alter this dynamic to the detriment of hares and lynx, and (3) the limited ability of land managers (at that time) to use fire to benefit hares and lynx, wildland fire management was identified as a "Lynx Risk Factor Affecting Lynx Productivity" (Ruediger *et al.* 2000, pp. 2-5, 5-2). To address these concerns, the authors developed objectives, standards, and guidelines for federal land managers to restore fire's role in maintaining lynx habitats, attempt to mimic historic natural fire regimes, and integrate lynx habitat objectives into fire management plans (Ruediger *et al.* 2000, pp. 7-6 - 7-8). They also directed federal land managers to evaluate whether fire suppression or other management practices had altered fire regimes and ecosystem function in potential lynx habitats and, where so, to use fire (naturally ignited fires or prescribed burns) as a tool to restore and maintain lynx habitat by creating or regenerating snowshoe hare habitat (Ruediger *et al.* 2000, p. 7-7).

In its 2000 listing rule and 2003 remanded determination, the Service recognized the potential for fire suppression to adversely affect lynx and hare habitats at local and regional scales, particularly in the Great Lakes Region, where fire suppression policies across land ownerships l kely prevented fire from assuming its natural role in creating a landscape mosaic of vegetation communities and age classes (65 FR 16076; 68 FR 40095). In the Northeast, the Service concluded that the very long fire return intervals and maritime influence in lynx forest types indicated that fire did not historically play a significant role in creating or maintaining lynx and hare habitats and, thus, fire suppression was unl kely to have affected lynx habitat (68 FR 40094). In the West, the Service concluded that the effects of fire suppression were likely lower in lynx forest types because of their typically long fire return intervals compared to lower and drier forest types (65 FR 16074; 68 FR 40093-94). Overall, the Service concluded that fire suppression did not represent a threat to lynx in the Northeast and was a low-magnitude threat in Great Lakes, S. Rockies, and N. Rockies/Cascades (65 FR 16075-16076; 68 FR 40093-40098).

In response to the guidance provided in the LCAS, the USFS, when developing the NRLMD and the SRLA to amend forest plans to address lynx conservation (see 3.1.1, above), evaluated whether fire suppression had adversely affected potential lynx habitats on national forests in the Northern and Southern Rockies. The USFS concluded that many forests in potential lynx habitat are in Condition Class 1, which means they have not missed a fire cycle because large, stand-replacing fire only occurs every 100 to 200 years; the long fire return interval has not been affected to any large degree by more recent fire suppression as is the case in drier forests with short fire return intervals; and they are close to historic conditions (USFS 2007, pp. 18, 20; USFS 2008, p. 11). In addition to the national forests covered by the NRLMD and SRLA (all national forests in the Northwestern Montana/Northeastern Idaho, GYA, and Western Colorado SSA units), the Superior National Forest, which accounts for 45 percent of the Northeastern Minnesota unit, revised its forest plan to adopt lynx conservation measures consistent with the LCAS (USFS 2004, Appendix E). The Okanogan-Wenatchee National Forest in the North-central Washington unit is currently revising its management plan and continues to manage for lynx conservation in accordance with the LCAS, including direction to restore fire to its natural ecological role and to use it as a tool to restore and maintain hare and lynx habitats.

As described above in section 3.1.1, current federal management on most USFS and BLM lands, in accordance with formally revised or amended management plans, includes limits on the proportion of lynx habitat within LAUs that can be in an unsuitable condition at any given time, including such conditions, usually temporary, created by wildfire. Although some exemptions and exceptions to these limits are permitted for activities to reduce fire risks to communities and infrastructure in the wildland-urban interface (WUI) or to achieve other resource benefits, even these potential impacts are limited on the larger landscape scale (USFWS 2007, p. 7). These conservation measures and the direction to use fire management as a tool to restore hare and lynx habitats and return to natural temporal and spatial patterns of fire disturbance, which were not in place when the DPS was listed, likely further reduce what was even then considered the low potential threat to lynx of past fire suppression activities. Based on the information above, we conclude that fire suppression and other fire management activities have not substantially impacted lynx and hare habitats in the DPS range and are unlikely to do so in the future.

However, warming temperatures attributed to climate change are reducing snowpack, causing earlier snowmelt and longer and more extensive droughts, resulting in longer wildfire seasons and increased fire frequency, size, and intensity in boreal forests of the north and in boreal and montane forests in some parts of the DPS range (Weber and Flannigan 1997, entire; Stocks *et al.* 1998, entire; Gillett *et al.* 2004, entire; Kasischke and Turetsky 2006, entire; Soja *et al.* 2007, entire; Pierce *et al.* 2008, entire; Flannigan *et al.* 2009, entire; Krawchuk *et al.* 2009, entire; Le Goff *et al.* 2009, entire; Bergeron *et al.* 2010, entire; Salathe *et al.* 2010, entire; Abatzoglou 2011, entire; McKelvey *et al.* 2011, entire; Abatzoglou and Kolden 2013, entire; Pederson *et al.* 2013, p. 1815; Price *et al.* 2013, pp. 342-343, 352-354; Barbero *et al.* 2014, entire; Trenberth *et al.* 2014, entire; Barbero *et al.* 2015, entire; Jolly *et al.* 2015, entire; Lute *et al.* 2015, entire; USEPA 2015, entire; Lienard *et al.* 2016, entire; Littell *et al.* 2016, entire; Westerling 2016, entire; see also section 3.2 above). Increases in fire frequency and size have the potential to adversely affect lynx and hare habitats in the DPS range by rapidly converting large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats (ILBT 2013, p. 70). Although this would likely be a temporary impact, with burned areas subsequently regenerating into higher-quality habitat, it would likely reduce landscape-level hare densities and, therefore, lynx numbers, potentially compromising an area's ability to support a resident lynx population until burned habitats recover.

Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already naturally marginal in many parts of the DPS range, it is possible that very large wildfires or many over a short time period could, perhaps in concert with other influencing factors, tip an area from just barely capable of supporting a resident lynx population to no longer capable of doing so, resulting in extirpation. For example, multiple large fires in north-central Washington over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). It may take 35-40 years for these areas to

recover as lynx and hare habitat (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and other habitat impacts could further diminish habitat availability and the lynx population's probability of persistence (Lewis 2016, pp. 5-6; Lynx SSA Team 2016, p. 44; also see section 2.3.2.2, above, and sections 4.1.4 and 5.1.4, below). The loss of habitat resulting from these fires and its potential demographic impacts on the State's only resident lynx population contributed substantially to the Washington Department of Fish and Wildlife's recent recommendation to uplist lynx from threatened to endangered under its State Endangered Species Program (Lewis 2016, entire).

Wildfire frequency, size, and intensity have also increased in the Northwestern Montana/ Northeastern Idaho geographic unit, where about 4,172 km^2 (1,611 mi^2; over 15 percent of the unit) have burned in western Montana from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20). Large fires have also impacted lynx habitat in the Western Colorado geographic unit, where fire size, frequency, and intensity are expected to increase with climate change (Ivan *in* Lynx SSA Team 2016, p. 23). As mentioned in section 2.3.2.2, large areas of the GYA unit were burned by the extensive wildfires of 1988. The extent to which those fires may have diminished lynx and hare habitats and contributed to the recent absence of resident lynx is uncertain, as is the potential for those burned areas to support high hare densities and resident lynx in the future. However, some burned areas may soon develop the dense horizontal conifer structure favorable for hares and, therefore, for lynx foraging habitat, perhaps increasing the likelihood that they may support resident lynx in the near future.

Although fire suppression was in the past thought to be a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

3.5 Habitat Loss and Fragmentation

Boreal forest habitats in the DPS are patchy and marginal for both snowshoe hares and Canada lynx. In this region, boreal forest transitions to various types of northern hardwood forest. The transitional nature of the boreal forest at its southern extent is believed (along with competition from other hare predators) to limit the numbers of both hares and lynx, preventing either from regularly achieving densities comparable to those regularly achieved in the classic boreal forests at the centers of their ranges in north-central Canada and Alaska (79 FR 54790). Lynx must contend with aspects of their habitat at the southern extent of the boreal forest for which they are not as well-adapted.

Fragmentation has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991). "Patchiness" is sometimes used to refer to natural processes (Buskirk *et al.* 2000a, p. 85), whereas and "fragmentation" to anthropogenic disruption of natural patterns. Habitat loss is conversion of forest to another land use or vegetative cover.

Forest loss and fragmentation are relatively low in the DPS compared to other forested regions in the United States (Heilman *et al.* 2002, p. 416). Since 2000 in the western United States, land uses associated with residential development, roads, and highway traffic have resulted in a 4.5% loss in area (20,000 km^2) of forest, and continued expansion of residential development will likely reduce forested patches by another 1.2% by 2030 (Theobold *et al.* 2011 (entire). Fragmentation in the forested western landscape resulted in a decline of weighted mean patch size from roughly 35,000 to 3,200 km^2 from natural to current conditions, but models predict relatively small declines in the size of forested patches over the next 30 years (Theobold *et al.* 2011 p. 2451). In the eastern United States, nearly half or more of the natural forest was cleared in the past three centuries but as agriculture and settlement relocated westward, eastern forest cover rebounded (Williams 1989, Smith *et al.* 2005). Maine's forest area has increased 0.79 percent since 1982 (Maine Forest Service, Department of Conservation 2010, p. 25). Similarly, a large portion of Minnesota forests were cleared in the last century, but forest cover has rebounded. The forest area in northern Minnesota has decreased 4 percent since 1977 (Miles *et al.* 2007, p. 22). Preliminary findings from the 2002 U.S. timber assessment (Haynes 2003) indicate that approximately 15 to 20 million acres of U.S. forest land could be converted to urban and developed uses over the next 50 years. Such land use conversions could result from residential development in forested landscapes, as the U.S. population is estimated to grow by another 126 million people.

Habitat fragmentation (both natural and anthropomorphic) directly affects snowshoe hares and lynx by various mechanisms; reducing hare survival and landscape hare densities, increasing lynx home ranges, reducing lynx reproduction and survival, and affecting lynx movements throughout the landscape. Habitat fragmentation also influences mesocarnivore communities that coexist with lynx and the level of competition for space and food resources. Fragmentation from anthropomorphic sources results in habitat alteration, direct habitat loss, vehicle collisions and behavioral disturbance from roads, and changes in landscape features such as edges.

Landscapes in which hare habitat is more contiguous, or where good patches of hare habitat are surrounded by other patches of similar habitat quality, support more hares than landscapes that are more fragmented or include matrix habitats that are poorer quality (Lewis *et al.* 2011, p. 565). Thus, southern transitional boreal forests generally have lower landscape snowshoe hare densities than boreal forests further north (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84). This may have as much to do with the quality of the matrix habitat between high quality patches as the hare densities that occur in the high quality patches themselves (Lewis *et al.* 2011). Low-quality matrix habitat, typical throughout much of the DPS, could decrease survival for hares, because predators might have higher hunting success or be more numerous in the matrix habitats (Griffin and Mills 2009). In contrast, a high-quality matrix, typical of Canadian boreal forest, can provide alternative or supplemental resources (Dunning *et al.* 1992; Norton *et al.* 2000), thus supporting higher densities of hares in the prime habitats.

The patchy distribution of hares and differences between landscape hare densities in the contiguous United States require lynx in most areas to incorporate more land area into their home ranges than lynx do in the north to acquire adequate food (Mowat *et al.* 2000, pp. 265, 277–278). At some point, landscape hare densities become too low, making some areas incapable of supporting lynx. Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range.

Throughout the northern part of their range, snowshoe hares are found in continuous areas of boreal forest; conversely, southern populations occur primarily in insular patches of suitable habitat set amidst less-preferred areas (Wolff 1980; Keith *et al.* 1993). This disparity has led a number of biologists to speculate that habitat fragmentation may be ultimately responsible for the non-cycling nature of snowshoe hare populations in the northern U. S. and southern Canada (Dolbeer and Clark 1975; Buehler and Keith 1982; Keith *et al.* 1993, Strohm and Tyson 2009). Wolff (1980, 1981) described the mechanism by which a fragmented habitat might dampen or eliminate cyclic population fluctuations.

Forest fragmentation may exacerbate competition between lynx and other predators (Buskirk *et al.* 2000a, entire). Fragmentation and competition are strongly linked because vegetation mosaics in landscapes provide high quality environments for generalist species such as the bobcat, red fox, and coyote (Goodrich and Buskirk 1995, Buskirk *et al.* 2000a, p. 84). Under such conditions, generalist predators tend to dominate the predator guild in fragmented landscapes (Oehler and Litvaitis 1996). Hares fluctuate less dramatically in the southern part of the range of lynx, thus there is more competition for a limited resource and exploitation competition inflicted by generalists (e.g., coyotes) and other predators (Buskirk *et al.* 2000a, p. 95).

Snowshoe hares in the south are concentrated in isolated patches of suitable habitat and subject to predation by a suite of generalist predators (e.g., Litvaitis *et al.* 1985; Sievert and Keith 1985; Keith *et al.* 1993; Cox *et al.* 1997). Keith *et al.* (1993) found that extremely high predation rate on hare living in high quality hare habitats, rather than predation on naturally dispersing individuals, seemed to be driving the changes in distribution and abundance in a snowshoe hare population in Wisconsin. In this study, predation pressure on populations occupying small (<7 ha) patches of preferred habitat was so severe that 3 of the 5 populations under investigation went extinct in the course of the 3-year study. Fragmentation of landscapes exacerbate the effect of predation by allowing carnivores to concentrate their hunting efforts on small patches of habitat used by their preferred prey instead of preying disproportionately on dispersing individuals (Wirsing *et al.* 2003, p. 170). In predator-rich landscapes characteristic of the DPS, this can result in intense predation and competition for a limited prey resource.

Lynx seem to be flexible in their response to habitat fragmentation whereas closely related species, such as bobcats and Iberian lynx, are sensitive to habitat fragmentation (Ferreras 2001, Crooks 2002). In a southern Ontario landscape Hornseth *et al.* 2014 (pp. 8-9) demonstrated that lynx exhibited a wide range of responses to habitat alteration. In general, lynx

responded most positively to areas having greater than 50 percent suitable habitat and generally avoided areas having less than 30 percent suitable habitat. However, lynx showed no sensitivity to the degree of forest fragmentation in areas of high or low suitable habitat.

All of these factors likely lead to lower reproductive output and more tenuous conservation status for lynx in many parts of the DPS relative to those in Canada and Alaska (Buskirk *et al.* 2000a, p. 95). Thus, factors that further fragment boreal forests in the DPS (e.g., climate change, forest management, roads and development) further reduce the probability of persistence of lynx.

The snow environment in the DPS is also patchy and marginal in both space and time for snowshoe hares and Canada lynx. Snow depth (Hoving *et al.* 2005, Peers *et al.* 2013, entire) and duration (Gonzales *et al.* 2007) give lynx a competitive advantage over generalist predators in the conterminous United States. Too little snow or crusting conditions favor competitors and predators like bobcat, fisher, and coyotes. High elevations may provide snow conditions that favor lynx, whereas low elevations favor conditions for competitors. Lynx may have competitive advantage at higher elevations in the DPS in the winter, but not in summer months when competitors may have free access to all habitats. In contrast, extensive deep, fluffy snow conditions favor lynx in broad areas of north-central Canada and Alaska.

Landscape features further fragment hare and lynx habitat. In lynx units in the western contiguous U.S., potentially suitable boreal forests and appropriate snow conditions occur in relatively narrow elevational bands in the Cascade and Northern and Southern Rocky mountains. Thus, appropriate habitats for lynx are naturally fragmented by topography and vegetation gradients. These “islands” of habitat can be extensive (e.g., the Okanagan in Washington or most of northwestern Montana) or smaller and relatively isolated (e.g., the Garnet Range in western Montana) depending on topography and precipitation patterns. Some of these areas of boreal forest are separated by unsuitable habitats in the low valleys (e.g., sage flats, urban corridors, agricultural lands) or by snow regimes (e.g. snow shadows) that may restrict lynx dispersal between habitat patches. In some western parts of the DPS range, lynx habitat in is also fragmented by rugged, high elevation terrain (Carroll *et al.* 2001, p. 976). In other areas of the DPS where there is little topography, including Minnesota and Maine, matrix forest facilitates lynx movements between suitable habitats. Large rivers are unlikely to fragment habitat as lynx readily swim across large bodies of water (Feierabend and Kielland 2014, entire) or cross them on ice in the winter (Koen *et al.* 2015).

Snow is an important component of lynx habitat (79 FR 54809). Snowfall can be patchily-distributed, variable and unpredictable from year to year, and affected by local topography, water bodies, and climate gradients. Snow conditions that provide lynx a competitive advantage over other terrestrial hare predators are most consistent in the high-elevation regions of the western U.S., although snow alone does not constitute lynx habitat (i.e., many places receive sufficient snow but lack other features lynx need, typically adequate hare densities). Snow conditions are less consistent in the East. For example, lake-effect snow from Lake Superior can increase snow depth and duration in the Arrowhead region of Minnesota in some years, but

not others. The Gulf of Maine has the reverse effect, and its warming influence reduces snow depth and duration inland. Distr bution models by Hoving (2001, p. 74) indicate that eastern Maine has extensive areas of boreal forest but does not achieve snowfall thresholds that gave lynx an advantage over bobcats and other competitors.

Lynx populations are clearly most viable in areas having extensive, unfragmented boreal forest habitats with large patches of high-quality foraging habitat and persistent deep, fluffy snow. Both lynx and hares are influenced by the spatial arrangement of preferred habitat. In Ontario, lynx preferred habitats with a high degree of connectivity (Walpole *et al.* 2012, p. 769). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Several studies (Koehler 1990a, Mowat *et al.* 2000, von Kienast 2003, Maletzke 2004, Squires and Ruggiero 2007, Squires *et al.* 2010) have reported that lynx avoid large openings, especially during winter. Mowat *et al.* (2000) suggested that relatively few snowshoe hares use large openings, and consequently lynx spend little time hunting in these areas. Koehler (1990a) speculated that vegetation management prescriptions that result in distance to cover >100 m (328 ft) may change lynx movement and use patterns until such time as sufficient reestablishment of forest vegetation occurs. Opening size can also influence seedling regeneration and stocking densities (Kreyling *et al.* 2008).

Similarly, individual lynx have the smallest home ranges and greatest survival and productivity in landscapes that have extensive, large patches of habitat in combination with deep, fluffy snow. Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that landscapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Anthropogenic Sources of Fragmentation - Human activities can exacerbate the natural habitat fragmentation that is typical throughout much of the DPS range. Anthropogenic activities such as forest management, development, and highways alter natural landscape patterns. They cumulatively can reduce the total area of habitat, diminish the quality of habitat, increase the isolation of habitat patches, and impair the ability of lynx and other wildlife to effectively move between patches of habitat. Anthropogenic fragmentation may be permanent, for example by converting forest habitat to residential, industrial, or agricultural purposes, or temporary, for example by conducting forest management but allowing trees and shrubs to regrow. Habitat fragmentation (both natural and anthropogenic) increases the risk of extirpation of small lynx populations.

Human-caused fragmentation of the already naturally patchy pattern of lynx habitat in the contiguous U.S. can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. Maintaining a mosaic of large (>100 acres) patches of young to old stands in patterns that are representative of natural ecological processes and disturbance regimes would be conducive to long-term conservation of lynx (ILBT 2013, p. 77).

Roads, development, climate change, and forest management fragment snowshoe hare and lynx habitat in the DPS. We know little about how hare and lynx respond to these anthropomorphic changes to their habitat, which requires additional research (Murray *et al.* 2008, p. 1464; Squires *et al.* 2013, p. 194). In the next decades, southern lynx populations will incur further habitat loss and fragmentation and the effects of climate change. Changes in habitat, prey base, and competitor guild will further stress southern lynx populations and possibly populations in southern Canada. Ultimately, the extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in its current southern range (Murray *et al.* 2008, p. 1469).

Roads - Paved highways fragment lynx habitat. In the West, they typically follow natural features such as rivers, valleys, and mountain passes that may have high value for lynx in providing habitat or connectivity. They surround large blocks of lynx habitat in Minnesota and northern Maine. Various studies have documented lynx crossings of highways. A male lynx in western Wyoming was documented to have successfully crossed several 2-lane highways during exploratory movements (Squires and Oakleaf 2005). However, in Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx (Bayne *et al.* 2008). Apps *et al.* (2007) found lynx were 13 times less likely to cross the Trans-Canada Highway relative to random expectation, but only 2.2 and 3.1 times less likely to cross smaller highways (93 and 1A, respectively). In southeastern British Columbia, lynx avoided crossing highways within their home ranges (Apps, 2000). Squires *et al.* 2013 (p. 194) documented 44 radio-collared lynx with home ranges within an 8 km buffer of 2-lane highways, however, only 12 of these individuals crossed the highway (Squires, unpublished data).

Paved highways also pose a risk of direct mortality to lynx and may inhibit lynx movement between previously connected habitats. If lynx avoid crossing highways, this could lead to a loss of effective habitat within a home range and reduced interaction within a local population (Apps *et al.* 2007). Lynx and other carnivores may avoid using habitat adjacent to highways, or become intimidated by highway traffic when attempting to cross (Gibeau and Heuer 1996, Forman and Alexander 1998).

Carnivores are especially vulnerable to highway-caused mortality in areas with dense and high traffic volume roadways (Clevenger *et al.* , 2001). As the standard of roads increases from gravel to 2-lane or 4-lane highways, traffic volumes and the degree of impact are expected to increase. Walpole *et al.* (2012, p. 770) found that small logging roads with low traffic volume had no effect on lynx distribution. Four-lane highways, such as the interstate highway system, commonly have fences on both sides, service roads, parallel railroads or power lines, and impediments like "Jersey barriers" that make successful crossing more difficult, or impossible, for wildlife (ILBT 2013, p. 78). Alexander *et al.* (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. In Colorado, lynx successfully and repeatedly crossed major highways, including I-70 (J.Squires, personal communication 2012; Ivan 2011b, c, 2012). Colorado lynx crossed two-lane highways an average of 0.6 times per day and more frequently during dusk and night when traffic volume was lower (Baigas *et al.* 2017, p. 204). They also crossed 4-lane highways (I-70), especially forested areas under large, elevated bridges that spanned streams (Baigas *et al.* 2017, p. 204).

Between 2000 and 2015, 54 lynx were reported to have been killed on roads (both paved and unpaved) in Maine (J. Vashon, Maine Department of Inland Fisheries and Wildlife, unpub. data), 11 in Minnesota (T. Smith, U. S. Fish and Wildlife Service, unpub. data), 1 in Idaho and 5 in Montana (compiled by K. Broderdorp, U.S. Fish and Wildlife Service, unpub. data 2016). Between 1995 and 2011, 15 lynx were reported killed on British Columbia highways (British Columbia Wildlife Accident Reporting System 2012). Most of these mortalities are on higher speed paved highways. However, in Maine, about 41 percent (22 of 54) were killed on lower speed dirt logging roads.

Translocated animals may be more vulnerable to highway mortality than resident lynx (Brocke *et al.* 1990), because they often move extensively after their release and are unfamiliar with their surroundings. In the Adirondack Mountains of New York, an attempt to reintroduce lynx failed and 18 of 37 mortalities of translocated animals were attributed to road kills (Brocke *et al.* 1990). Over a 7-year period in Colorado, 13 of 102 documented mortalities of translocated lynx were killed on highways (Devineau *et al.* 2010). Traffic volumes on Colorado highways where the 13 lynx mortalities occurred were estimated to range from about 2,300 to >25,000 vehicles per day (K. Broderdorp, personal communication 2012).

Roads of all sizes have many indirect effects to lynx including increased human access (e.g. trapping and illegal shooting), and creating edge habitats that promote co-occurrence with competitors like coyotes and bobcats (Bayne *et al.* 2008, p. 1195).

Vegetation Management - As described in section 3.3, above, forest management can further fragment boreal forest in the northern contiguous United States affecting habitat suitability for both snowshoe hares and lynx. Large-scale forest fragmentation or maturation can be deleterious to snowshoe hares because they become increasingly restricted to small patches with adequate cover, and higher predation rates from a variety of carnivores tend to increase

local extinction risk (Wolff 1981, Keith *et al.* 1993, Wirsing *et al.* 2002; see also Barbour and Litvaitis 1993).

Although some forest management can benefit lynx by creating or maintaining a shifting mosaic of lynx habitat, it can also be detrimental by fragmenting habitat into small, widely-spaced parcels. Changes to vegetation structure can increase landscape resistance to lynx movements (Squires *et al.* 2013). In Montana, fragmentation from forest thinning decreased the probability of lynx movements across the forested landscape (Squires *et al.* 2013, p. 192). Lynx in the Northern Rockies are sensitive to changes in forest structure and tend to avoid large forest openings (Koehler, 1990; Squires *et al.* , 2010) like recent clearcuts and thinned areas. In Maine, the shift to partial harvesting forms of forest management will continue to increase the number of patches of high quality hare habitat, but it will greatly reduce the size of patches and increase their isolation (Simons-Legaard *et al.* 2016, pp. 5-6). This is diminishing landscape conditions conducive to supporting lynx.

Residential and Commercial Development - Residential and commercial development is increasing on private forest lands. Increased traffic and urbanization are projected for the Northern Rockies (Hansen *et al.* 2002) and Maine (section 5.1.1). It is uncertain to what degree lynx can tolerate habitat fragmentation from roads and forest clearing, and how human and pet activity affect lynx use of habitats. Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat *et al.* 2000). The degree to which residential development and associated roads reduce connectivity of mesocarnivore populations (including lynx) likely depends on the physical design of highway improvements, the surrounding environmental features, the density of increased urbanization, and the increased traffic volume (Clevenger and Waltho, 2005; Grilo *et al.* 2009).

Ski Resorts - Ski areas have similar effects on permanent habitat loss and fragmentation. One ski run is often separated from the next only by small inter-trail forest islands. Ski runs often are intermixed with other open areas such as open or gladed bowls, rock outcrops, or barren tundra ridges. Ski resorts that are built or expanded in lynx habitat may impact lynx by removing forest cover, reducing the snowshoe hare prey base, and creating or increasing human disturbance in or near linkage areas. There is limited information on lynx behavior and habitat use in and around ski areas. Lynx have been known to incorporate smaller ski resorts within their home ranges, but may not utilize the large resorts. Preliminary information from an ongoing study in Colorado suggests that some recreational use may be compatible, but lynx may avoid some areas with concentrated recreation use. In some areas, lynx habitat may be limited and concentrated in the ski area development footprint (J. Squires, personal communication 2012).

More than 50 ski areas exist throughout the range of the lynx in the contiguous U.S. (ILBT 2013, pp. 82-83). Most ski areas are located on north-facing slopes, where ample snow conditions provide for extended ski/snowboard recreational seasons. In the western states, many of these landscapes feature spruce-fir forests. While ski resorts occupy a small proportion of the landscape, spruce-fir forests provide important habitat for snowshoe hares and lynx at the

southern extent of their range. In winter, alpine and Nordic skiing and snowboarding are the primary uses. Most of these resorts offer year-round recreation, with summer activities typically including h king and mountain biking.

Mining Leasable Minerals - Activities associated with exploration and development of leasable minerals occur primarily in western units of the DPS. Very little mining development occurs in Minnesota and northern Maine. Mining affects lynx habitat by changing or eliminating the native vegetation, human disturbance, and contributes to habitat fragmentation. Development of a high density of wells, as is typical of coal-bed methane development (e.g., 1 well per 2–4 ha [5–10 ac]), could affect lynx by directly removing habitat or causing sufficient human presence to displace lynx. The development of associated roads, powerlines, and pipelines to facilitate exploration and development also result in a loss of lynx habitat and contribute to fragmentation of habitat. In some areas, for example in the Wyoming Range, extensive oil and gas development is occurring within lynx habitat.

Locatable Minerals - Only a fraction of the historical number of mines is operating today. Those that continue to operate do so with more stringent environmental protection measures. However, in some parts of the United States, minerals exploration and new development seem to be increasing. Activities associated with exploration and development of locatable minerals could affect lynx habitat by changing or eliminating the native vegetation, and by contributing to habitat fragmentation. The effects can be variable depending on the size of the associated mining operation or development. Locatable minerals are extracted through both open pit and sub-surface mines with potential habitat alteration ranging from tens to thousands of hectares. In some instances, such as larger mining operations, land exchanges are conducted to consolidate private ownership of the surface above a deposit prior to mine development. Depending on lands exchanged this could retain lynx habitat in public ownership, but could still result in a net loss of habitat. Development of road and railroad access to facilitate exploration and development also directly impact lynx habitat, contribute to fragmentation, facilitate increased competition as a result of snow-compacted routes, and result in direct mortality. Despite these potential effects, mining exploration and development is generally anticipated to affect only a small portion of lynx habitat in the contiguous United States.

Salable Minerals - In general, salable minerals are found close to the surface. During exploration activities, equipment is moved to the site and a number of test pits are dug or holes drilled to determine the quality of material. If desired minerals are found in suitable quantity, then vegetation is removed and materials are excavated. For example, gravel pits are needed for logging road development and maintenance and are common occurrences throughout areas of the DPS that are in active forest management. Areas developed for salable minerals can vary in size from a single truck load to tens of acres. Impacts to lynx include the potential alteration or removal of lynx habitat, increased fragmentation, and the potential for human-caused mortality from road development.

Wind Energy - Wind energy development and associated transmission lines in lynx habitat is increasing across the nation. Facilities are located on ridge tops or other areas exposed to

consistent wind. The construction of wind facilities including access roads may result in loss of lynx habitat and increased fragmentation from permanent forest clearings. Noise and human activity associated with the construction and operation of wind facilities could disturb or displace lynx from important habitats. Effects would likely continue through the life of the project, which may exceed 20 years.

Utility Corridors - Utility corridors contain developments such as overhead or buried powerlines and gas pipelines, and often are located within or adjacent to existing road rights-of-way. Utility corridors potentially could have short- or long-term impacts to lynx habitats, depending on location, type, vegetation clearing standards, and frequency of maintenance. Those that are extensively cleared of vegetation and maintained in grass or herbaceous vegetation likely equate to a permanent habitat loss. When associated with highways and railroads, utility corridors may further widen the right-of-way. Utility corridors may facilitate human access into previously remote areas thus exposing lynx to increased trapping and possible illegal shooting.

Agriculture - Agricultural activity is not expanding currently in lynx habitat areas in the DPS range. In fact, in the late 1800s, over 3 million acres of northern Maine was in farming, compared to about 700,000 acres today (Ahn *et al.* 2002, p. 8). Most of the current farming is in northeastern Maine, where it fragments the forested landscape corridor between core habitats in northern Maine and western New Brunswick, Canada. Forest clearing for agriculture may have contributed (along with increasing road densities and an expansion in coyote distribution) to the recent contraction in the southern part of lynx range in eastern Alberta (Bayne *et al.* 2008, p. 1195).

Habitat Loss and Fragmentation in Corridor Areas Connecting Lynx Populations in the DPS with Adjacent Populations in Canada - Lynx conservation in the contiguous U.S. is thought to depend in part on maintaining connectivity with habitat areas and lynx populations in Canada. Maintaining connectivity for lynx may become increasingly difficult because of climate change and other anthropogenic influences, as evidenced by reduced connectivity for other boreal species (van Oort *et al.* 2011). Potential corridors have been identified in the northern Rockies (Squires *et al.* 2013, entire). There are likely broad, forested corridors with suitable dispersal habitat connecting core habitats in Maine to southern Quebec and northern Minnesota to southern Ontario. Given the perceived importance of lynx immigration from Canada to the persistence of the DPS (FR 68 40076– 40101, Squires *et al.* 2013, p. 187), roads and other forms of habitat loss and fragmentation that may impede lynx movements in the border regions of Canada and the U.S. are of concern.

Chapter 4: Current Conditions

In this chapter, we present our understanding, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the current status of the lynx DPS in terms of redundancy, representation, and resiliency. . We then provide brief summaries of the current conditions in each geographic unit, followed by a more detailed evaluation of the status of lynx populations and habitats and the factors currently believed to

influence them in each unit. Where appropriate, we compare our current understanding to what was known or believed when the DPS was listed under the ESA in 2000 and to our understanding of historical conditions.

4.1 Summary of Current Conditions DPS-wide

Because of the limitations and uncertainty in the historic records of lynx occurrence in the contiguous U.S. (described above in section 2.3.2.1), it is difficult to compare the current distribution and status of resident lynx populations in the DPS with what may have been the historical condition (but see evaluation in section 2.3.2.2, above). However, research and surveys over the last two decades have significantly improved our understanding of the current distribution, habitats, and the status of resident populations compared to what was known when the DPS was listed in 2000. For example, although we knew there were some resident lynx in Maine (Unit 1), we did not have a feel for population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS, that extensive clear-cutting in the 1970s and 1980s in response to a large spruce budworm outbreak has created the current abundance of high-quality lynx habitat, and that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain whether Minnesota (Unit 2) supported a resident population. We now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. (Units 3, 4, 5, and 6) are naturally less abundant and more patchily-distributed than was thought at the time of listing, and several areas thought to have historically supported small resident populations currently do not (the GYA [Unit 5], the Garnet Mountains in western Montana [Unit 3], and the Kettle Mountains of northeastern Washington). We also know that recent extensive wildfires in north-central Washington (Unit 4) have reduced (probably temporarily) the amount of high-quality lynx habitat and likely caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado (Unit 6), although the current number of lynx there is unknown and their distribution uncertain.

With regard to redundancy, defined as the ability of the DPS to withstand catastrophic events, we find that the current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southern Colorado. Resident breeding lynx populations currently occupy five of the six geographic units (all but the GYA; Figure 1). Of the five occupied units, four are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2) (see tables 1, above, and 4, below). Lynx experts indicated no catastrophic event that could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS and, further, no or a very low likelihood of functional extirpation of any of the individual geographic units due to a single catastrophic event (Lynx SSA Team 2016, p. 56).

Because we lack evidence that persistent lynx populations have been lost from any other large geographic areas in the contiguous U.S., it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. That is, the loss of resident lynx populations in the DPS, to the extent suggested by verified historic records, was likely in areas (e.g., northern New Hampshire, Michigan's Upper Peninsula, the Kettle/Wedge area of northeastern Washington, perhaps Isle Royale in Lake Superior) peripheral to the geographic units that currently support resident lynx. Any small populations that were lost were not in large, discrete geographic units that would have represented substantially greater redundancy in the contiguous U.S. However, the implications of the potential recent loss of resident lynx in the GYA for the redundancy of the DPS are unclear. The historic record and recent research show that the GYA has supported resident lynx. However, it is unclear whether the area consistently supported a resident breeding population over time or whether it naturally supported resident lynx only some of the time ("winked on" in a metapopulation sense) when habitat conditions and hare densities were favorable, and at other times, when habitats and hare densities were less favorable, it did not support resident lynx ("winked off" in a metapopulation sense). Given the protected conservation status of millions of -acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. If so, the contribution of the GYA to redundancy within the DPS is questionable.

Representation, defined as the ability of the DPS to adapt to changing environmental conditions, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Lynx experts and geneticists indicated high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Although hybridization with bobcats has been documented in the DPS (in Maine and Minnesota), it is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Further, despite differences in forest community types and other habitat parameters (e.g., topographic/elevation settings) lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Therefore, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. Because there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions, we find that the DPS currently displays an adequate level of representation.

Resiliency, the ability to withstand stochastic disturbance events, is currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. However, because we lack reliable estimates of the sizes and

trends of most lynx populations in the DPS, we are unable to use these parameters to evaluate the current resiliency of individual populations or geographic units. Although some demographic data (survival, reproductive rates) are available for each geographic unit (see Table 3, below), they were collected using different methods, at different times and for different intervals, and possibly at different points in hare population cycles or fluctuations and, therefore, do not provide a consistent measure of resiliency. Efforts to understand resiliency within the DPS are also confounded by the metapopulation structure thought to govern lynx populations at the southern margin of their continental range, which suggests that some populations may be naturally ephemeral (i.e., “winked on” when conditions are favorable; “winked off” when conditions are not favorable). The related uncertainty about the extent to which DPS populations may rely on cyclic immigration of lynx from Canada during population irruptions and the ambiguity in the historic record that limits our understanding of the relative persistence of lynx in various geographical areas also limit our ability to characterize, rank, or model the relative contribution of each geographic areas to the resiliency of the DPS.

Despite uncertainties and data deficiencies, qualitative factors provide some hints about current relative resiliency among some geographic areas or parts of them. For example, in Maine, lynx appear to have demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the possible extirpation of lynx populations in the GYA (Unit 5) and in the Garnet Mountains of Unit 3 may indicate the lower level of resiliency expected among small and relatively more isolated populations. The persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population; however, the post-fires increase in home range size and likely decrease in lynx numbers may indicate the population is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Overall, the apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historic conditions suggest adequate historical and recent levels of resiliency of lynx populations in the DPS.

In summary, the lynx DPS currently exhibits adequate redundancy to preclude extirpation as a result of catastrophic events. The genetic health and ecological diversity expressed across the DPS range l kewise suggest a currently adequate level of representation. The long-term persistence and apparent broad geographical distribution of lynx populations in four of the six geographic units also suggests the current adequacy of resiliency in the DPS, although the potential recent extirpation of several small populations may be an indication of inadequate resiliency in those places.

4.1.1 Summaries of Current Conditions in Each Geographic Unit

Unit 1 - Northern Maine: This geographic unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) in northern Maine, but small areas of similar habitat also occur in northern New Hampshire and northern Vermont. Resident lynx in this unit are part of a larger population that also occupies southern Quebec and northern New Brunswick, Canada. At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that the largest reproducing resident population of lynx in the DPS likely occurs in this unit (numbers and trends unknown, but enough habitat exists to support possibly 500 to 1000 lynx). Small numbers of reproducing lynx have also been documented recently in northern New Hampshire and northern Vermont. Historically, lynx distribution in this unit was patchy, and lynx populations were likely low and dependent on immigration from Canada. Forest management is now the primary driver of hare and lynx habitat in this DPS unit. Current lynx and hare habitat is historically high because of young, regenerating softwood forests created by extensive clearcutting and herbiciding to salvage spruce-fir following a severe spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Lynx responded to these conditions with high survival and reproduction, small home ranges, and moderate population densities. State forestry regulations passed in 1989 caused landowners to shift to various forms of partial harvesting that have resulted in lower landscape hare densities across much of the unit. Hares do not seem to cycle in this region, but underwent a 50 percent decline starting in 2006 and have remained at lower levels. Reproduction and survival rates in the low-hare environment suggest a slightly declining population. Unlike other units of the DPS, lynx habitat in northern Maine occurs nearly entirely on private, industrial forest lands, and landowners do not have long-term commitments to lynx management. The majority of lands in Maine are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with hare and lynx habitat. Other potential stressors on private lands include large-scale wind energy development, residential and resort development, and parcelization of forestlands from rapid turnover in investment company landowners. The next spruce budworm outbreak is imminent, but forestry response by investment landowners is uncertain. Climate change is a concern as snow depth and duration are currently at the minimum thresholds believed necessary to give lynx a competitive advantage over bobcats and other mesocarnivores. There is currently no clear evidence of climate change effects on lynx distribution.

Unit 2 - Northeastern Minnesota: This geographic unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps, and black spruce or tamarack bogs. Despite uncertainty when the DPS was listed, it has become apparent that a reproducing resident population of roughly 50 to 200 lynx exists in northeastern Minnesota. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario, where trapping of lynx is legal. Lynx in Minnesota select regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites are associated with regenerating and mixed forest (Burdett 2008, p. 57). Hare densities in parts of northeastern Minnesota appear to be sufficient to support a viable lynx population; and densities

are highest in regenerating forests (McCann and Moen 2011, p. 513). The Superior National Forest continues to manage in accordance with its 2004 Forest Plan, and several risk factors are being minimized and managed to promote the conservation of lynx within the SNF. Management of lynx habitat on state and private lands is voluntary. Factors affecting current conditions in this unit primarily include forestry management, roads, incidental trapping, mining development, snow compaction, competition with bobcats, and lynx-bobcat hybridization. Forty-nine lynx mortalities due to vehicle and train collisions as well as incidental trapping and shooting have been reported in Minnesota since the species was listed.

Unit 3 - Northwestern Montana/Northeastern Idaho: There are no reliable estimates of current or historic resident lynx numbers in this geographic unit, but it is thought to be capable of supporting 200-300 lynx home ranges. Habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Minor genetic differences suggest three subpopulations in the northwest (Purcell Mountains), central (Seeley Lake), and southern (Garnet Mountains) parts of the unit. No lynx have been detected in the Garnets after 2010, but whether this indicates the extirpation of a small (7-10 individuals) previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit, including federal, State, Tribal, and some private lands, is managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire supporession) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx, with the Garnets being a possible exception. Wildfire extent has increased over the past several decades, likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Hare densities have not been estimated broadly throughout the unit but appear to be low or marginal even in most of what is considered the highest-quality habitat, suggesting that even small decreases in habitat quality/hare densities could influence its continued ability to support resident lynx. The role of past and recent immigration in maintaining the demographic and genetic health of current lynx populations in this unit is unknown, but peaks in cyclic lynx numbers in Canada have declined, especially when compared to the unprecedented irruptions of the early 1960s and 1970s, and there is no evidence of significant immigration into this unit since then.

Unit 4 - North-central Washington: This geographic unit encompasses approximately 5,176 km^2 (1,988 mi^2), 91.5 percent federally owned. It contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia, directly north of this unit, and maintaining connectivity with Canada is considered important to maintaining lynx populations in this unit. There are no reliable estimates of current or historic resident lynx numbers in this unit, but recent habitat and home range analyses (summarized in Lewis 2016) suggest that it may have been capable of supporting 65-90 lynx prior to recent large wildfires. Those fires affected about 50 percent of the potential lynx

habitat, led to increased home range size, and may have reduced the current carrying capacity of this unit to 40-55 lynx. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943). There is significant risk for potential future wildfires to further affect the viability of lynx in this geographic unit. Burned habitats are expected to regenerate back into suitable lynx habitat, but this may take 35-40 years. The Kettle Range to the east of this unit was suspected to have supported a small (likely fewer than 20 individuals) resident population until about 30 years ago when over-trapping may have resulted in its extirpation (Koehler *et al.* 2008, p.1523). Potential impediments to lynx movement between the Kettle Range and the Cascades and British Columbia may make natural recolonization of the Kettle Range unlikely. Results of snowshoe hare research suggest that the hare population density in Washington exists at the low end of the range thought necessary to support lynx reproduction (>= 0.5 hares/ha). The OWNF and CNF, which administer more than 90 percent of lynx habitat in Washington, continue to manage lynx habitat on their forests in accordance with the LCAS. Additionally, the WADNR, which manages approximately 4 percent of lynx habitat in Washington, has developed and is implementing its 2006 Lynx Plan, which is also largely based on the LCAS.

Unit 5 - Greater Yellowstone Area (GYA): There are no reliable estimates of current or historic lynx numbers in this unit but, given its naturally-fragmented potential habitat, generally low hare densities, and the paucity of verified records, it appears unlikely this unit ever supported a large resident population. No lynx have been verified in this unit after 2010, but whether this indicates the extirpation of a small but previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit consists of federal lands (97.5 %) that are currently managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx. Wildfire extent has increased over the past several decades, predominantly in the northern half of the unit and likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Snow conditions currently appear to be adequate, with most of this geographic unit modeled to have a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12). Hare densities were very low in most of Yellowstone National Park but high in parts of the Bridger-Teton National Forest in the southern half of the unit. The role of past and recent immigration in maintaining the demographic and genetic health of lynx populations in this unit is unknown. This unit lacks direct connectivity to other lynx populations, and there is only anecdotal evidence that irruptions of lynx from Canada resulted historically in immigration into this unit. Some lynx released in Colorado dispersed northward into this unit and temporarily occupied home ranges in areas used previously by native resident lynx, but there is no evidence of reproduction among these lynx.

Unit 6 - Western Colorado: Lynx habitat in Colorado is distributed west of US Interstate-25. This unit is not directly connected to lynx populations in Canada. Compared to the time of listing and completion of the Southern Rockies Lynx Amendment, two bark beetle epidemics have altered

large areas of lynx habitat in Colorado. Similarly, large wildfires have reset successional conditions in many areas. Areas affected by beetles that contained multistoried stand conditions l kely continue to provide habitat to support snowshoe hares and lynx. Areas affected by beetles and fire require 20 plus years to recover to a point where the stands will again support snowshoe hares. The CPW completed their lynx reintroduction, and based on information generated during on-going studies, and reports received by CPW and the USFS, lynx continue to persist, at least in the San Juan Mountains. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell undocumented pers comm. April 4, 2016), and Rocky Mountain National Park (Shenk 2008, page 3). Habitat that supports snowshoe hares is patchily distr buted in this geographic unit, which limits their abundance. Because the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. The majority of lynx habitat in Colorado continues to be managed by the USFS, providing conservation through the Southern Rockies Lynx Amendment. However, regulatory mechanisms for the conservation of lynx are lacking on approximately 3,611 km^2 (1,394 mi^2) [14 percent] of some BLM, NPS, and other non-federal lynx habitat.

Table 3. Summary of current conditions in six geographic units within the DPS range.

	Unit 1 - Northern ME	Unit 2 - Northeastern MN	Unit 3 - Northwestern MT, Northeastern ID	Unit 4 - North-central WA	Unit 5 - Greater Yellowstone Area	Unit 6 - Western CO
Unit Size (km^2)	28,909	21,101	26,997	5,176	23,687	25,294
Percent of Unit in Conservation Ownership (i.e., Federal, State, Tribal, Other Conservation Org.)	<10	75 - 90	> 95	> 90	> 95	> 90
Connectivity to Lynx Populations/ Habitats in Canada	Directly connected to lynx habitats/ populations in s. Quebec and n. New Brunswick; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Ontario; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Alberta and s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown
Home Range Size (Adult Female, km^2)	26	17 - 21	43 - 115	37 - 91	50 (1 female, 3 years)	75 - 704
Productivity – Percent Females with Kittens	89% (high hares); 30% (low hares);	100%	83% (Purcells); 61% (Seeley Lake)	100% (2 females)	Few data	24%
Productivity - Litter Size	2.74 (high hares); 2.25 (low hares)	3.3	2.95 (Purcells); 2.24 (Seeley Lake)	2.25 (2 females)	3.0 (1 female, 2 years)	2.75
Average Annual Adult Survival Rate	0.80 (high hares); 0.71 (low hares)	0.75 - 1.00	0.85 (Purcells); 0.75 (Seeley Lake)	0.86	Few data	0.93 (in Core Release Area [CRA]), 0.82 (out of CRA)
Lambda (Annual Rate of Population Change)	1.16 (high hares, 6 yrs); 0.88 (low hares, 4 yrs)	No estimate	1.16 (Purcells, 4 yrs); 0.92 (Seeley Lake, 8 yrs)	No estimate	No estimate	No estimate

4.2 Current Conditions - Detailed Descriptions by Geographic Unit

4.2.1 Unit 1 - Northern Maine

The “Northern Maine unit” includes the core, occupied habitat in northern Maine, which is designated critical habitat. It also includes areas where lynx have recently occurred in western and eastern Maine and northern New Hampshire and Vermont. To be consistent with the Workshop Report, we refer to this collective region as the Northern Maine unit.

Unit Description: This unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) primarily in northern Maine, but also small areas of northern New Hampshire and Vermont. Climate in this region is characterized by warm summers and some of the coldest temperatures and highest snowfalls in the eastern U. S.; a function of latitude, elevation, and distance from the ocean. The average terrain rises in northern Maine to 1,000-1,500 feet with mountain peaks, particularly in western Maine, northern New Hampshire and Vermont from 3,000 to 5,000 feet. This region is far enough inland to be unaffected by marine influences. Annual precipitation is 41 inches (104 cm), with greatest precipitation in winter in the form of snow 228 cm to 280 cm (90 to 110-plus inches), with higher amounts at higher elevations. Snow duration is about four months (mid-November through mid-April).

Maine - Much of the lynx habitat in northern Maine occurs within the designated critical habitat boundary, which is approximately 28,909 square kilometers (11,162 square miles) all in northern Maine (79 FR pp. 54823-54828). Land ownership in the critical habitat unit boundary is about 92 percent private, 7 percent State (primarily Baxter State Park), 1 percent tr bal (Passamaquoddy Tribe, Penobscot Indian Nation), and contains no federal land. Private lands are almost entirely commercial forest lands. Lynx regularly occur outside of the designated critical habitat boundary in parts of eastern and western Maine and, recently, in northernmost New Hampshire and Vermont (see below).

New Hampshire - Habitat in northern New Hampshire is not within the designated critical habitat. Potential habitat is limited (Hoving 2001, p. 59), and the few habitat patches that support lynx in New Hampshire are much smaller than those in northern Maine (Litvaitis and Tash 2005, Fig. 2 and p. A–298; Robinson 2006, Fig. 3.3, p. 99). Hoving (68 FR 40086) estimated approximately 1,000 square kilometers (386 square miles) of potential habitat having a greater than 50 percent probability of being occupied by lynx. Litvaitis and Tash (2005, p. A–298) estimated that New Hampshire contains about 342 km2 (888 km2) of potential Canada lynx habitat. Historic distribution in New Hampshire included Coos and northern Carroll and Grafton counties (i.e. White Mountain National Forest; Siegler 1971, Silver 1974, Hoving *et al.* 2003). Habitats with the highest probability of occurrence are in Pittsburg in northern New Hampshire and the White Mountain National Forest in the central area of the state (Siren 2014, p. 34). The majority of the habitat in northern New Hampshire is located on the Connecticut Lakes Natural Area WMA which is owned and managed by NHFG. Surrounding habitat is owned and managed by the Connecticut Lakes Timber Company under a conservation easement held by the State of NH. Occurrence records from the past 10 years have been

centered on these two ownerships (Kilborn 2015, App. A pp. 42-43). Habitat on the Connecticut Lakes Natural Area has a conservation easement with 15,000 acres of the core lynx habitat also being part of an unmanaged area of the 25,000 acre property. As a result these core 15,000 acres will be allowed to mature to a climax forest type potentially allowing for good denning habitat but restricting the amount of snowshoe hare habitat in the foreseeable future. Current conditions are in a transition state, and portions of the 15,000 acres are supporting higher densities of snowshoe hare because of past forest management (Kilborn 2015, App. A pp. 42-43). Regional-scale modeling suggests that a high component of deciduous forest and insufficient snow conditions in New Hampshire are unlikely to support viable lynx populations over time (Hoving *et al.* 2005, pp. 739, 749).

Vermont - Habitat in northern Vermont is not within the designated critical habitat. Recent modeling to determine lynx habitat connectivity in the Northeast suggests that the Nulhegan River Basin contains Vermont's best lynx habitat (Farrell 2012). The 530 square kilometer (205 square mile) area is approximately 20 percent federal (Nulhegan National Wildlife Refuge), 17 percent State (Vermont Department of Natural Resources), and 63 percent private commercial timber lands (with easement). The future of lynx and their habitat is unlikely because of the patchy and limited amount of habitat, climate change (decreasing snow), trends toward hardwood management, and increasing human disturbance (Vermont Fish and Wildlife 2015, Appendix A5 p. 127).

The Northern Maine geographic unit is directly connected to lynx habitats and populations in southern Quebec and northern New Brunswick, Canada. Lynx in this unit represent the southern extent of a larger cross-border population, most of which occurs in the Gaspe region of southern Quebec and northern New Brunswick (Ray *et al.* 2002, pp. 17-20). Lynx in the northern Maine unit are geographically isolated by the St. Lawrence River from lynx populations in central Quebec (120 km north of Maine). Lynx populations in Maine and eastern Canada are geographically isolated from other lynx populations on the island of Newfoundland (900 km east of Maine), and on Cape Breton Island, Nova Scotia (650 km southeast of Maine) (Koen *et al.* 2015, entire). The closest lynx population in the DPS is located in northeastern Minnesota, about 1,700 km west of Maine.

Habitat Description: In the northern Maine unit, most lynx occurrence records are found within the broadly described ''Mixed Forest-Coniferous Forest-Tundra'' cover type (68 FR, p. 40086). This habitat type occurs along the northern Appalachian Mountain range from southeastern Quebec, western New Brunswick, and western Maine, south through northern New Hampshire. This habitat type becomes naturally fragmented and begins to diminish to the south and west, with a disjunct segment running north-south through Vermont, and a patch of habitat in the Adirondacks of northern New York (McKelvey *et al.* 2000b, pp. 248-250). This area is part of the Acadian Forest Region (Rowe 1972, p. 112-129) representing a transition between northern boreal spruce and balsam fir and southern temperate deciduous forests (Seymour and Hunter 1992, pp. 3-4). Northern Maine is characterized by low-relief, hilly terrain, but with some higher elevations up to 1,600 meters (Katahdin highlands, western Maine, White Mountains in central New Hampshire). Higher elevations support a predominantly coniferous forest (white, red, and

black spruce; balsam fir; eastern white pine) intermixed with northern hardwoods (red maple, aspen, white birch, sugar maple, beech, and yellow birch). Lowland areas include spruce-fir flats interspersed with peatlands (black spruce, tamarack).

Current lynx and hare habitat are associated with spruce-fir stands repeatedly harvested for forest products. Hares and lynx are associated with stands of regenerating sapling (15–35 years old) spruce-fir forest that provide dense cover (Robinson 2006, pp. 26–36; Vashon *et al.* 2012, p. 15). Lynx are more likely to occur in large (100 square kilometer, 40 square mile) landscapes having a high percentage (>27 percent) of regenerating forest, and less likely to occur in landscapes with very recent clearcut or partial harvest (Hoving *et al.* 2004, pp. 291–292, Simons-Legaard *et al.* 2013, entire). Regenerating stands used by lynx generally develop after forest disturbance (almost exclusively logging) and are characterized by dense horizontal structure and high stem density within a meter of the ground. These habitats support the highest snowshoe hare densities (Homyack 2003, p. 63; Fuller and Harrison 2005, pp. 716, 719; Vashon *et al.* 2005a, pp. 10–11). At the stand scale, lynx in northwestern Maine selected older (11- to 26-year-old), tall (15 to 24 feet (ft) (4.6 to 7.3 meters (m)) regenerating clearcut stands and older (11- to 21-year-old) partially harvested stands (Fuller *et al.* 2007, pp. 1980, 1983–1985). At the home range scale, lynx also select landscapes having some mature conifer forest (Simons-Legaard *et al.* 2013, pp. 572–573). Lynx may select partial harvested and mature conifer stands because of increased ease of travel and prey access along the extensive edges with high-quality (regenerating clear-cut) habitats (Simons-Legaard *et al.* 2013, p. 574).

Most of the high-quality hare and lynx habitat in northern Maine is the result of extensive landscape-scale clearcut timber harvesting in response to a spruce budworm outbreak in the 1970s–1980s (Simons 2009, pp. 64, 218). Some of these clearcuts were also treated with herbicides to promote conifer regeneration by suppressing deciduous tree species. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). Historically, the natural disturbance regime (fires, windthrow, insect outbreaks) resulted in smaller, more frequent disturbances and long intervals between larger disturbances.

Snowshoe hare populations in Maine do not seem to cycle at 10-year intervals, but have experienced a period of high (1995-2005) and low (2006 to present) populations (Scott 2009, pp. 1-44, D. Harrison, UMaine, unpub. data, Vashon *et al.* 2012, p. 14). Prior to 2006, several estimates of hare densities in the highest quality, regenerating conifer or mixed forest averaged 1.9 (Homyack *et al.* 2007, p. 8) to 2.1 hares/ha (Robinson 2006, p. 26,). After 2006, hare densities declined by about half in all stand types and have remained at these lower levels (Scott 2009, p. 109, D. Harrison, UMaine, unpub. data). Similar trends were observed in the Gaspe Region of Quebec (Assells *et al.* 2007, entire). In 1990, hare densities in dense, regenerating spruce-fir stands in New Hampshire were 0.5 hares/ha at low and high elevation (Brocke *et al.* 1990, p. 61). More recently, Siren *et al.* (2015) reported lower densities in New Hampshire (0.25 to 0.36 hares/ha) in both montane and lowland spruce-fir. Densities in high elevation (krumholtz, stunted spruce-fir) were only 0.19 to 0.28 hares/ha. Comparable hare

density data are not available for Vermont or New York. The average landscape hare density in home range-sized areas occupied by lynx in Maine was 0.74 hares/ha (Simons-Legaard *et al.* 2013, p. 567). Based on these observations, Simons-Legaard *et al.* (2013, p. 576) recommended maintaining landscape hare densities of at least 0.74 hares/ha (or 27 percent of 100 km2 areas in high-quality hare habitat) to conserve lynx.

Habitat Status: As elsewhere in the DPS, boreal spruce-fir forest habitats in the northern Maine unit are patchily distributed and intermixed with northern hardwoods, riparian areas, and peatlands. USFS forest inventory data indicate that four million acres of forestland are classified as spruce-fir in Aroostook, Penobscot, Piscataquis, and Somerset Counties in northern Maine (McWilliams *et al.* 2005, p. 122), although not all of this forest type is in areas occupied by lynx. In a 10 million acre area in northern Maine (approximately 50 percent of the designated critical habitat), Simons-Legaard (2016, p. 9-10) estimated that approximately 950,000 acres (9.5 percent) of spruce-fir was in a young, regenerating stand condition that provide high quality hare habitat. This habitat is similar to, and contiguous with, forested areas in Quebec and New Brunswick, Canada that support lynx (Hoving *et al.* 2005, pp. 740-741). The current range of lynx in the northern Maine unit is associated with areas of deep snowfall, extensive (100 km2 [40 mi2]) forested landscapes, and areas having a high proportion of regenerating conifer-dominated forest that had previously been treated with herbicides to suppress hardwoods (Homyack 2003, p. 2; Hoving *et al.* 2004, p. 287).

Lynx habitat in the northern Maine unit is associated with large-scale, intensive forest management (Harper *et al.* 1990, entire; Hoving *et al.* 2004, pp. 291-292; Simons 2009, p. 8; FR 74 8616–8701). Patches of boreal forest in New Hampshire, Vermont, and New York are more highly fragmented and smaller than in northern Maine. These more southerly forests also contain a higher proportion of northern hardwood. These forests are believed to lack the conifer component needed to produce sufficient snowshoe hare densities to consistently support viable populations of lynx (Hoving *et al.* 2005, p. 749, Carroll 2007, p. 1100).

During winter, lynx primarily selected tall (4.4–7.3 m [14.5–24 ft]) regenerating clearcuts and partially harvested stands that were 11–21 years post-harvest (Fuller *et al.* 2007, pp. 1984-1985). Lynx avoided mature stands (>40 years old) and short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partially harvested stands <10 years post-harvest (Fuller *et al.* 2007, pp. 1275-1278). Further research of year-round habitat use yielded similar results, with lynx preferentially using conifer-dominated sapling stands that were 3.4–7.3 m (11–24 ft) in height and supported high densities of snowshoe hares (Vashon *et al.* 2008b, pp. 1492-1495). Lynx tended to forage in areas with intermediate to high snowshoe hare densities (tall regenerating or older partial harvest stands), which afforded lynx with greater mobility and where snowshoe hares were more vulnerable to predation, rather than in the densest stands (short regenerating stands; Fuller and Harrison 2010, pp. 1276-1278).

Denning habitat included various types of coarse woody debris; blowdown, deadfalls, and root wads. In northern Maine, the majority of natal dens (12 of 26) occurred in conifer-dominated

sapling stands, and 6 dens were found in mature or mixed multi-story forest stands dominated by conifers (Organ *et al.* 2008, pp. 1515-1517).

In general, landscape scale and home range scale habitat selection by lynx on industrial forest lands reinforce the importance of dense regenerating conifer forest along with a component of mature conifers (Hoving *et al.* 2004, p. 286; Vashon *et al.* 2008a, pp. 1494-1495, Simons 2009, pp.64-110; Simons-Legaard *et al.* 2013, p. 568). Simons-Legaard *et al.* (2013, p. 573) found the probability of lynx occurrence was >50 percent when snowshoe hare landscape densities were >0.74 hares/ha (0.39/ac) and there was >10 percent mature conifer forest. In Maine, lynx selected softwood-dominated (spruce and fir) regenerating stands (Fuller *et al.* 2007, pp. 1983-1985; Vashon *et al.* 2008a, pp. 1492-1495) and adjacent older (11–21 years post-harvest) partially-harvested stands (Fuller *et al.* 2007, pp. 1983-1985). Lynx were more likely to occur in landscapes with abundant regenerating forest, and less likely to occur in landscapes dominated by recent clearcut or partially harvested stands (Hoving *et al.* 2004, pp.289-292). Regenerating stands used by lynx typically developed 15–30 years after harvest (Hoving *et al.* 2004, p. 291), and were characterized by high stem density and dense horizontal cover within 1 m (3 ft) of the ground (Robinson 2006 pp. 33-35, Scott 2009, pp. 81-93; Fuller and Harrison 2010, p. 1276-1278). These habitats supported high snowshoe hare densities (Homyack 2003, p. 53; Fuller and Harrison 2005, p. 716, Vashon *et al.* 2008a, p. 1492; Scott 2009, pp. 24, 32, 36-44). At a landscape scale, lynx habitat selection did not differ between sexes; however, at a home range scale, males tended to use more mature forest dominated by conifers than females, and both male and female lynx tended to avoid mature forests that had a high deciduous component (Vashon *et al.* 2008a, pp. 1492-1493).

Historically lynx habitat in the northern Maine unit was l kely uncommon. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). In the Northeast prior to European settlement, lynx habitat was created and maintained by frequent, small-scale forest gap dynamic events and infrequent, large-scale stand-replacing forest disturbances (Seymour *et al.* 2002, pp. 359-365; Lorimer and White 2003, pp. 54-58). Higher elevation boreal forests are often characterized by an even-aged wind-throw phenomenon known as fir-waves (Sprugel 1976, entire). Large, stand-replacing events (fire, wind and ice storms, insect outbreaks) are rare (interval of several hundred to several thousand years) and highly variable in size (Seymour *et al.* 2002, entire; Lorimer and White 2003, pp. 50, 54, 59). Spruce budworm, spruce beetle, beech bark disease, and sugar maple defoliators have been important influences affecting forest landscape patterns (McNab and Avers 1994, Chapter 14). The frequency and intensity of spruce budworm outbreaks, the most likely insect to affect lynx habitat, have been highly variable in Maine and eastern Canada in recent centuries (Blais 1983, entire). In this geographic area, wildfire is less significant as a natural agent of disturbance. The typical fire regime is infrequent surface fires in the dormant season in the hardwood forests, and slightly more frequent but long-interval fires in conifer forests (Kilgore and Heinselman 1990, entire; Seymour *et al.* 2002, pp. 359-365, Lorimer and White 2003, p. 59). For the past several decades, early successional forests and lynx habitat in northern Maine, New Brunswick, and

southern Quebec have been created almost exclusively by forest management (Lorimer and White 2003, pp. 42-43).

In contrast, current habitat is likely peaking and at historical highs. Favorable habitat conditions for snowshoe hare and lynx in Maine resulted from large-scale salvage cutting (clearcutting) following a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, p. 291). After salvage harvest of the affected trees, a portion of the area was sprayed with herbicide to reduce deciduous competition (Scott 2009, pp. 7, 14). The resulting vegetation was dominated by balsam fir and red or black spruce (Scott 2009, p. 60). This created favorable habitat conditions for snowshoe hares and lynx. Habitat conditions for hares and lynx in the unit improved from the late-1980s to present, benefitting from stand-replacing salvage harvests during the last budworm outbreak (Simons 2009, pp. 122-229; Simons-Legaard *et al.* 2016, entire). During this time period, the percentage of forestland with an average landscape hare density greater than 0.5 hares/ha increased 400 percent (Simons-Legaard *et al.* 2016, p. 7).

Lynx habitat will decline in the near future. In response the widespread clearcutting in the 1980s, in 1989 Maine passed the Forest Practices Act. This Act regulated clearcutting. Various forms of partial harvesting replaced clearcutting as the predominant form of forest management in northern Maine. Partially harvested stands (e.g., selection harvest, shelterwood harvest, overstory removal) have a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006, p. 29). On average, partially harvested stands support about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006, p. 26-27).

Maine's forest practices shifted dramatically after the Maine Forest Practices Act. Over 95 percent of cutting that occurs now in northern Maine is partial harvesting compared to 59 percent in 1988 (Scott 2009, p. 8; Simons 2009, pp.45-47, 69-71; Simons-Legaard *et al.* 2013). This new cutting regime supports lower landscape densities of snowshoe hares (Fuller 1999, Homyack 2003, Robinson 2006, Scott 2009).

Long-term, binding land management commitments are lacking in the northern Maine unit. Unlike federal lands, there is no requirement that private landowners comply with lynx management guidelines, and a federal nexus for review of projects is almost nonexistent. Furthermore, there continues to be high turnover in forest land ownership (Hagan *et al.* 2005, Nadeau-Drillen and Ippoliti 2006) and little funding to provide incentives or to work with private landowners. As of 2005, there were 23 landowners in northern Maine with land holdings in excess of 100,000 acres including the State, federal government (White Mountain National Forest south of lynx range), a conservation group (The Nature Conservancy), two tribes (Penobscot Indian Nation and Passamaquoddy Tribe with much land south of lynx range) and 18 private forest landowners (Nadeau-Drillen and Ippoliti 2006, p. 13).

There are short-term commitments to manage lynx habitat in the northern Maine unit. In 2003, Congress passed the Healthy Forest Restoration Act. Title V of this Act designates a Healthy Forest Reserve Program (HFRP) with objectives to: (1) promote the recovery of threatened and

endangered species, (2) improve biodiversity, and (3) enhance carbon sequestration. In 2006, Congress provided the first funding for the HFRP, and Maine, Arkansas, and Mississippi were chosen as pilot States to receive funding through their respective Natural Resources Conservation Service (NRCS) State offices. Based on a successful pilot program, in 2008, the HFRP was reauthorized as part of the Farm Bill, and in 2010, NRCS published a final rule in the Federal Register (75 FR 6539) amending regulations for the HFRP based on provisions amended by the bill.

In 2006 and 2007, the NRCS offered the HFRP to landowners in the proposed Canada lynx critical habitat unit in Maine to promote development of Canada lynx forest management plans. Since that time four private landowners, The Nature Conservancy, the Passamaquoddy Tribe, Merriweather LLC, and Katahdin Forestlands successfully enrolled in the program. Collectively, these land ownerships comprised 943.2 mi2 (2,443 km2), or 9.3 percent of the total designated critical habitat in northern Maine.

The NRCS required that lynx forest management plans must be based on the Service's ''Canada Lynx Habitat Management Guidelines for Maine'' (McCollough 2007, entire). These guidelines were developed from the best available science on lynx management for Maine. The guidelines required maintenance of landscapes having hare densities that support reproducing lynx populations. Notably, HFRP forest management plans provided a net conservation benefit for lynx, which was achieved by employing the lynx guidelines, identifying baseline habitat conditions, and meeting NRCS standards for forest plans. Plans met NRCS HFRP criteria and guidelines and complied with numerous environmental standards. Plans were reviewed and approved by the NRCS with assistance from the Service. The details of the plans are proprietary and will not be made public per NRCS policy.

Short-term commitments to lynx management will expire in 2016 and 2017. Unlike lynx forest plans on federal lands, HFRP plans lack long term commitments beyond an initial 10-year contract period. Plans were prepared for a forest rotation (70 years) and include a decade-by-decade assessment of the location and anticipated condition of lynx habitat on the ownership. However, landowners are only committed to a 10-year contract, and long-term commitments to lynx management are voluntary. Some landowners developed plans exclusively for lynx, and others combined lynx management (umbrella species for young forest) with American marten (umbrella species for mature forest) and other biodiversity objectives. All four plans have been completed and contracts with NRCS will expire in 2016 and 2017. Landowners have the option to convert HFRP contracts into Safe Harbor Agreements or other agreements to provide regulatory assurances, however, at this time this option has not been explored with landowners.

Many large private forest landowners in the northern Maine unit have commitments to endangered species management through forest certification programs. For example, The Nature Conservancy land enrolled in the HFRP is also enrolled in the Forest Stewardship Council (FSC) forest certification program, which requires safeguards for threatened and endangered species. Other landowners are certified under the Sustainable Forestry Initiative (SFI). Both certification programs require planning for threatened and endangered species.

However, certification programs are also voluntary and may not be long-term commitments. Given the frequent turnover in Maine forest lands, new landowners do not always renew certification or resume the certification programs initiated by the previous landowner.

Lynx Status: At the time of listing, lynx were known to be present in northern Maine but little was known about their distr bution, population size, and trend, snowshoe hare populations, and relationships to forest management. Since then, research from the Maine Department of Inland Fisheries and Wildlife (Vashon *et al.* 2008a, entire; 2008b, entire; and 2012 entire) and the University of Maine (Hoving *et al.* 2003, entire; Hoving *et al.* 2004, entire; Hoving *et al.* 2005, entire; Homyack *et al.* 2005, entire; Homyack *et al.* 2007, entire; Homyack *et al.* 2006, entire; Fuller *et al.* 2007, entire; Fuller *et al.* 2004, entire; Fuller and Harrison 2005, entire; Simons-Legaard *et al.* 2013, entire; Simons-Legaard *et al.* 2016, entire) have greatly increased our knowledge. Snow track surveys and confirmed occurrence records (Vashon *et al.* 2012, entire; Siren 2015, entire) document that lynx occur throughout northern Maine and in small, isolated pockets in western and eastern Maine, northern New Hampshire, and Vermont (Siren 2015, entire). Population size and trends are still uncertain.

The Northern Maine Unit currently supports a breeding population of lynx that encompasses most of northern Maine, with recent lynx occurrence and reproduction also documented in northernmost New Hampshire and Vermont. This geographic unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspe region of southern Quebec. Extensive areas of contiguous forestland in this region provide high connectivity between populations in Maine and Canada. Although potential lynx habitat in New Hampshire and Vermont is fragmented, there is near contiguous forest and connectivity for lynx movement between these areas and habitats in northern Maine (Farrell 2013 personal communication, FR 54821). Breeding lynx in New Hampshire and Vermont are not directly connected to Canadian populations, but they are connected to the larger population in northern Maine via habitat in western Maine.

Lynx in the Northern Maine Unit and adjacent populations in southern Quebec and northern New Brunswick are separated from lynx populations in the interior of Canada. The St. Lawrence River restricts lynx dispersal and demographically isolates this population from those in northern Quebec, Labrador, and Ontario. However, sufficient numbers of individuals cross the river on the ice each generation to prevent genetic drift of this population (Koen *et al.* 2015).

At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that a significant population currently exists and is supported by the extensive young, regenerating spruce-fir habitat created by clearcutting in the 1970s and 1980s. Habitat in northern Maine can support lynx densities in localized areas of high quality habitat that are substantially greater than elsewhere in the DPS (LCAS 2013, p. 23). In 2003 when hare populations were high, lynx density (juveniles and adults) in one of Maine's highest quality habitats was estimated to be 9.2-13.0 lynx/100km^2 (Vashon *et al.* 2008, Vashon *et al.* 2012, p. 15). At about the same time, the density of lynx in nearby Gaspe Peninsula, Quebec was estimated to be 10 lynx/100km^2 (Ray *et al.* 2002). These densities are intermediate to those

in Canada during the high (17.0-44.9/100km^2) and low periods (2.3 – 3.0/100km^2) of the lynx-hare cycle (Poole 1994, Slough and Mowat 1996, O'Donaghue *et al.* 1997). Simons (2009, p. 102) estimated there is potential for a population of about 236 to 355 adult lynx to occur on a 3.56 million acre study area (about half of the critical habitat area) in northern Maine, and Vashon *et al.* (2012, appendix IV) estimated there is potential for a population of 750 to 1,000 adult lynx in all of northern Maine in 2006. The actual number of lynx is unknown because there are no methods available to measure and produce true population estimates over such a large geographic area.

Lynx populations in New Hampshire and Vermont may consist of only a few animals, although breeding has occurred in both locations in recent years. Most historic lynx records from New Hampshire are from trapping records from the 1930s to the 1960s (Brocke *et al.* 1993, McKelvey *et al.* 2000). There were only two records in the 1990s. In 2003, the Service determined that, despite a lack of breeding records, a small resident population likely occurred historically in New Hampshire but no longer exists (68 FR 40087). Lynx were detected in northern New Hampshire in 2006 and have occurred there annually since (Siren 2014 pp. 53, 55). In 2011, 4 lynx kittens were observed in Pittsburg and were considered evidence of breeding in New Hampshire (Kilborn 2015 Appendix A p.44). There were only four historic records of lynx in Vermont prior to 2003. Since then, nine lynx sightings have been confirmed. Reproduction was first documented in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Vermont Fish and Wildlife 2015, Appendix A5 p. 126).

Lynx do not presently occur in the Adirondacks region of New York. A resident lynx population reportedly occurred in the northern region of New York, particularly in the Adirondack Mountains, but it was considered extirpated by 1900 (Brocke 1982, McKelvey *et al.* 2000b). However, there are 23 verified lynx occurrences since 1900, primarily from the Adirondack Mountains (McKelvey *et al.* 2000b). The most recent verified record was from 1973 (McKelvey *et al.* 2000b), which correlates to an extreme cyclic population high. Habitat and prey conditions were deemed suitable for a lynx reintroduction in 1989–1991 (Brocke 1982). The reintroduction was unsuccessful in establishing a population. In 2003 the Service concluded that a resident population may have existed in New York prior to 1900, however, records of lynx since 1900 are of dispersers (68 FR 40087).

Maine lynx had spatial and demographic parameters similar to some northern populations during the cyclic high in the snowshoe hare cycle (Brand *et al.* 1976, Parker *et al.* 1983, O'Donaghue *et al.* 1997). Maine lynx had among the smallest home ranges in the DPS (LCAS 2013, p. 24). During the period when snowshoe hare populations were highest, Maine lynx had among the highest reproductive rates (average litter size 2.74, 89 percent of adult females producing litters) in the DPS (Vashon *et al.* 2012, pp. 18-19). During the current period of low hare density, litter size was smaller, only 30 percent of females have litters, and mortality is greater. Home ranges are among the smallest in the DPS (54 + 5 km2 males; 26 + 4 km2 females, LCAS p. 24, Vashon *et al.* 2008a). Home range sizes were similar during periods of high and low hare density (Mallett 2014). Lynx populations likely increased during the period of

high hare density (lambda [λ] = 1.16) and declined during periods of low hare density (λ = 0.88) (USFWS, Vortex10, deterministic population simulation 2016; demographic data from Vashon *et al.* 2012).

In summary, Maine lynx and hare habitats are at historical highs. In the Northeast prior to European settlement, lynx habitat was created and maintained by small-scale, frequent forest gap dynamic events and large-scale, infrequent (stand-replacing) forest disturbances (Seymour *et al.* 2002, Lorimer and White 2003). Historically, lynx distribution was patchy, and lynx populations were likely low and dependent on immigration from Canada. Current habitat is the result of widespread clearcutting and herbiciding to salvage spruce and fir damaged by a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Maine lynx at multiple scales select extensive areas of regenerating, dense (7,000 – 14,000 stems/ha) spruce-fir stands 15 to 35 years after clearcut or other even-aged harvest (Hoving *et al.* 2005, Fuller *et al.* 2007, Vashon *et al.* 2008, Simons-Legaard *et al.* 2013). Lynx habitat is expected to remain stable for the next few years then decline (Simons-Legaard *et al.* 2016).

Factors Affecting Current Conditions: *Climate Change* - Climate change is affecting temperature, snow, and precipitation patterns in the Northeast at rates faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46º C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Climate change has, and will continue to affect lynx by reducing snow and boreal forest (see section 5.1.1).

Snow Duration, Depth, and Quality - As noted in chapter 2, lynx occur where there is regularly at least four months (120 days) of continuous snow coverage (Gonzales *et al.* 2007). Snow cover days in northern New England (1965-2005) ranged from 60-121 days and declined an average of 3.6 days/decade from 1965-2005 (Burakowski *et al.* 2008). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Thus, average conditions in Maine are currently at or below the snow persistence thresholds believed to be needed to support lynx (Gonzales *et al.* 2007). Similarly, the largest snow depth decreases in Canada in the last six decades have been observed in the lower St. Lawrence Valley, immediately north of Maine (Brown and Braaten 1998, pp. 48-52).

Lynx in the Northeast and eastern Canada occur where there is regularly total snowfall of at least 270 cm/yr (106 in/yr; Hoving *et al.* 2005), which defines the distribution of lynx and bobcat in this region (Hoving *et al.* 2005, Carroll 2007, Peers *et al.* 2013). Average annual snow depth at 5 weather stations within the range of the lynx in northern Maine (1981-2010) was below this threshold, 228-263 cm (NOAA 2011, http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html, last accessed 31 March, 2016). In the last 50 years, 18 of 23 snow sampling sites in and near Maine experienced reduce depth of snowpack (Hodgkins and Dudley 2006). Snow depth in New England (1965-2005) declined

an average of 4.6 cm/decade (Burakowski *et al.* 2008). Thus, average snow conditions in Maine are currently at or below this snow depth threshold, and further declines in annual snow depth would be expected to give bobcats a competitive advantage over lynx (Hoving *et al.* 2005,)

As noted in chapter 2, lynx and snowshoe hare require deep, fluffy snow that provides lynx with a competitive advantage over bobcats and gives hares the ability to reach winter browse. Snow quality ("fluffiness") has deteriorated in the Northeast. Unlike other units, annual precipitation in Maine is increasing because of climate change, but primarily as rain (A. Siren *in* Lynx SSA Team 2016, p. 15; Fernandez *et al.* 2016), and especially rain on snow events in winter in northern Maine (Huntington and Hodgkins 2004, Deser *et al.* 2013, Fernandez *et al.* 2015). Snow density and compaction and crust conditions (caused by wet, heavy snow or rain on snow events in winter) have increased in northern New England (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006) and southern Canada (Karl *et al.* 1993).

Vegetation Management - The effects of forest management on foraging and denning habitat for lynx in northern Maine are discussed in the Habitat Description and Habitat Status sections above.

Wildland Fire Management - Although fire is frequent in many boreal forest regions, it is not a stressor for lynx in northern Maine. Annual precipitation is comparatively greater in this unit than others, and conditions for fire are infrequent. The fire regime in this unit is infrequent (50- to 200-year interval) and generally small (several acres) surface fires in the dormant season. Large (up to 80,000 acres) stand-replacing fires are rare and occur at a less frequent interval (800- to 9000-years) (Seymour *et al.* 2002 p. 360). In contrast, spruce budworm outbreaks cause stand-replacement over large areas every 100–250 years (Cogbill, 1985).

Habitat Fragmentation - Habitat fragmentation (smaller and more isolated patches of high quality hare habitat) caused by current forest practices in northern Maine is discussed in the Habitat Description and Habitat Status sections above.

Other Factors: *Trapping* - This unit is directly connected to lynx habitats and populations in southern Quebec, where trapping of lynx is legal. Several lynx that were captured and radio-tagged in northern Maine were subsequently trapped in southern Quebec (Vashon *et al.* 2012).The lynx trapping season was closed in the Northern Maine Unit (including New Hampshire and Vermont) for decades prior to lynx being listed as a threatened species. Carroll (2007) modeled lynx populations in this unit and demonstrated that increased trapping pressure in Quebec could have a negative effect on protected lynx populations in Maine and New Brunswick. About 400 lynx are trapped and killed annually in Quebec south of the St. Lawrence River (http://mffp.gouv.qc.ca/english/wildlife/statistics/index.jsp last accessed May 19, 2016). In 2014, the Maine Department of Inland Fisheries and Wildlife (MDIFW) obtained an incidental take permit from FWS for lynx trapped incidental to other furbearer trapping in Maine. From 2000 to 2015, 108 lynx have been reported captured in traps set for other species and 7 of those were killed (Vashon *et al.* 2012, MDIFW 2014, p. 75). No lynx have been reported

incidentally trapped in New Hampshire or Vermont since 2000. In Maine, after two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions (e.g., requiring killer-type traps be placed in exclusion boxes, eliminating the use of drag sets for foothold traps) to further reduce mortality and injury of incidentally-trapped lynx.

Trapping of Canada lynx can be additive to other sources of mortality and have population-level effects (Brand and Keith 1979, Koehler and Aubrey 1994). Thus, harvest regulations for lynx are modified when hare and lynx populations are low (Bailey *et al.* 1986). Trapping mortality is not l kely to have a great effect on lynx populations in northern Maine and adjacent Canada when lynx are at historically high numbers, but trapping could have a synergistic and negative effect if hare and lynx populations decline, habitat declines, or climate change further stresses lynx (Slough and Mowatt 1996, Carroll 2007).

Wind Power Development - In response to climate change, wind development has escalated in northern and western Maine posing a potential threat to high and low elevation spruce-fir habitats (Whitman *et al.* 2013). Climate conditions are at or falling below threshold values needed to support lynx in Maine (see section above). Maine has experienced a rapid increase in wind energy development (http://www.eia.gov/electricity/data/browser, last accessed August 2, 2016), and there is increased interest in placing developments on private lands in unpopulated areas throughout northern Maine, New Hampshire, and Vermont. Wind energy is an increasingly appealing source of income for investment companies and other landowners who own forestland in the northern Maine unit. As of 2016, at least 11 wind projects have been proposed in northern Maine and 5 projects are in operation; 2 have been proposed in northern New Hampshire and 2 are in operation; and 3 have been proposed for northeast Vermont and 2 are in operation or under construction. Maine's two largest wind projects (combined over 200 turbines covering 360 mi2) are proposed entirely within Maine's lynx critical habitat. The effects of wind energy projects on lynx, hares and their habitat are undocumented. Potential direct effects include disturbance or displacement of resident lynx and loss and fragmentation of habitat from turbines, roads, and transmission lines. Increasing power infrastructure associated with these projects could greatly change development potential and patterns in northern Maine by bringing electricity into the interior of Maine's vast, undeveloped forest region. Extensive road construction further fragments habitat and increases access for recreation, including trapping.

Changing Land Ownership and Development - Until recently, the northern Maine unit was largely undeveloped, industrial forestland, but land ownership patterns have changed significantly in the last 15 years (Nadeau-Drillen and Ippoliti 2006). Some investment-oriented landowners are seeking diversified financial returns on their investment, including developing residential housing, second homes, and resorts. Two large residential and resort areas have been proposed on forestlands within the Maine critical habitat area. Both development projects would result in the development of several thousand acres of potential lynx habitat, but would be mitigated by substantial (100,000s of acres) conservation easements on surrounding forestland. Another private landowner proposes donation of a 87,000 acres within the lynx critical habitat for a federally-designated national park or monument. This area currently has a legacy of young-regenerating spruce-fir habitat from previous industrial forest landowners, but a park or

monument designation would forego future forest management. Another conservation landowner, The Nature Conservancy, continues forest management on about half of its 185,000 acre ownership, including managing part of the area for Canada lynx.

Construction or expansion of developed areas such as residential areas and resorts, as well as smaller recreational sites like nordic ski huts or campgrounds, may directly remove forest cover. Such removal in lynx habitat could decrease prey availability, affect lynx movement within home ranges, or result in a more fragmented landscape. Development further fragments habitat from road and highway construction (along with associated increases in traffic volumes and/or speeds).

Northern Maine Unit Summary - In summary, lynx are currently widespread throughout northern Maine and in small patches of habitat in northern New Hampshire and Vermont. Habitat exists to support a potential population of 500 to 1000 lynx, although the actual population size is unknown. Habitat created by extensive clearcutting 30 to 40 years ago is peaking and will decline by 50 percent in the next 15 to 20 years (Simons-Legaard 2016, p. X; also see section 5.1.1, below). Furthermore, hare populations declined by 50 percent starting in about 2006 and have remained at lower levels. Future hare fluctuations or cycles are uncertain. Active management of forest lands can produce lynx habitat, but landowners do not have long-term commitments for doing so. Land ownership has dramatically changed in northern Maine, and the majority of lands are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with lynx habitat. Greatest stressors are habitat loss (shifts in forest management from clearcutting to partial harvesting resulting in lower landscape hare densities), lack of forest planning for lynx, and climate change (diminishing snow depth, quality and duration; competition from bobcats and fishers; loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing ice conditions on the St. Lawrence River).

4.2.2 Unit 2 - Northeastern Minnesota

Unit Description: This unit encompasses approximately 21,100 square kilometers (8,147 square miles) in northeastern Minnesota. It includes the area designated as critical habitat in 2014 (79 FR 54782) and an additional relatively small area of tribal land in northern Minnesota that was excluded from critical habitat. Land ownership in this unit is about 47 percent federal (primarily USFS, with some NPS and BLM land); 36 percent State; 16 percent private; and 1 percent Tr bal (Grand Portage Reservation) (see Table 1). This unit includes most of Superior National Forest (SNF; including the Boundary Waters Canoe Area Wilderness [BWCAW]) and Voyageurs National Park. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit l kely represent the southern extent of a larger cross-border population, most of which occurs in Ontario (ON). Relative to other DPS lynx populations, this unit is about 1,480 km (920 mi) east of the Northwest Montana/Northeast Idaho Unit and about 1,610 km (1,000 mi) west of the Northeastern Maine geographic unit.

Habitat Description: In Minnesota, most lynx occurrences are associated with the Mixed Deciduous/Conifer Forest (McKelvey *et al.* 2000b, pp. 246, 248) within the Laurentian Mixed Forest Province (McNab *et al.* 2005, p. 5). Most of this province is characterized by low-relief hilly landscapes with glacial features and an elevation from sea level to 2,400 feet (730 meters), including many lakes and rivers. This unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps and black spruce or tamarack bogs. Coniferous and mixed-coniferous/deciduous vegetation types are dominated by balsam fir; black and white spruce; northern white cedar; Jack, white and red pine; hemlock; and tamarack; mixed with aspen and paper birch (Burdett 2008, p.5; Moen *et al.* 2009, pp.1-2; McCann and Moen 2011, p. 510). Burdett (2008, p. 57) reported that lynx in Minnesota selected regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites were associated with regenerating and mixed forest. McCann and Moen (2011, p. 513) found snowshoe hare densities were highest in regenerating forests. Females selected large woody debris and dense horizontal cover in lowland conifer cover for denning in northern Minnesota (Moen *et al.* 2008, p. 1510), but other cover types were used if recent blowdowns were present (Moen and Burdett 2009, p. 5).

Hare density in parts of northeastern Minnesota appears to be sufficient to support a viable lynx population (Moen *et al.* 2008, p. 1512), ranging between 0.3–2.0 hares/ha (0.12–0.8 hares/ac; McCann 2006, p. 17). Hare populations in northeastern Minnesota appear to be patchily distributed, but are most consistently abundant in 10-30 year old regenerating forests (McCann 2006, p.45). Pellet count data prior to the 1990s show evidence of density fluctuations of snowshoe hare populations occupying Minnesota (Fuller and Heisey 1986, pp. 262-263), but these fluctuations were not observed during the 1990s (Hodges 2000b, p. 172). Snowshoe hare habitat in Minnesota primarily consists of conifer forests with dense low-growing understories, lowland shrub and conifer bogs. Conifer bogs or lowland conifer forests may be especially important during low points in hare cycles by acting as refugia for hares. Early regenerating or pole-sized stands are not used as much as in other portions of their range, although older regeneration stands were used frequently in Minnesota (McCann 2006, p. 45). Sapling-sized aspen adjacent to conifer cover may also provide functional snowshoe hare habitat. McCann and Moen (2011, pp. 512-513) mapped the distribution of predicted snowshoe hare habitat across northeastern Minnesota. In northeastern Minnesota, edge habitats and regenerating conifer stands appeared to be important for snowshoe hare populations (Burdett 2008, p. 58; McCann 2006, p. 45), as were dense habitats containing balsam fir, white spruce, and cedar (Fuller and Heisey 1986, p. 263). Recent research indicates that the red squirrel is not an important prey species for lynx in northeastern Minnesota (Burdett 2008, p. 62; Hanson & Moen 2008, p. 9).

Average annual snowfall in this unit ranges from about 180 cm (71 in) in the northwestern part of the unit near International Falls, Minnesota to 219 cm (86 in) in Duluth, Minnesota, on the southern end of the unit, to 228 cm (90 in) in Tofte, Minnesota, near the lake shore on the far eastern-central part of the unit, to 228 cm (90 in) in Isabella, Minnesota, near the center of the unit, to the 107 cm (42 in) in Grand Portage, Minnesota, at the northeastern tip of the unit. More

snow is produced along Lake Superior, because of the lake effect (https://snowfall.weatherdb.com/d/a/Minnesota; accessed 4/25/2016).

Habitat Status: Friedman and Reich (2005, p. 732) conducted a spatially explicit forest composition change analysis on a 3.2 million hectare study area in northeastern Minnesota, which was based on General Land Office Survey records from the late 1800s and the 1990 USFS Inventory and Analysis Survey. The study documents altered forest tree species abundance, proportional basal area, and spatial distribution patterns. The proportionally most abundant species in northeastern Minnesota shifted from the presettlement period (spruce, 21 percent; larch, 15 percent; and paper birch, 15 percent) to aspen (30 percent), spruce (16 percent), and balsam fir (16 percent) in 1990. White pine declined from 20 percent to 5 percent basal area dominance, birch from 16 percent to 13 percent, spruce from 14 percent to 9 percent, and larch from 12 percent to 2 percent, while aspen increased from 8 percent to 35 percent basal area dominance.

In 2015, the SNF estimated that there were approximately 759,700 acres (60 percent of lynx habitat on the SNF) of suitable snowshoe hare habitat on the SNF and that only 23,800 acres of habitat on the SNF was in a condition unsuitable to lynx (USDA 2016, unpublished data).

The SNF continues to manage in accordance with its 2004 Forest Land and Resource Management Plan (USDA 2004, entire). The Forest Plan emphasizes providing sustainable amounts of timber, maintaining or enhancing biodiversity, contributing to economic and social needs of the community, and managing in an environmentally sound manner to produce goods and services that provide for long-term public benefits (USDA 2004, entire). The Forest Plan includes many objectives, standards, and guidelines for the protection of lynx and enhancement of lynx habitat that are based on recommendations in the 2000 LCAS. LAUs were delineated on the SNF in 2000 as the smallest landscape scale on which to analyze effects to lynx. The boundaries have remained in place since that time to allow for long term analysis of project effects. However, the SNF Plan proposed several changes of current LAU boundaries, such as adding LAUs to the Virginia Management Unit of the Laurentian Ranger District; designating the BWCAW a lynx refugium.

This unit is directly connected to lynx habitats and populations in southern Ontario, where trapping of lynx is legal. Habitat connectivity within and between portions of northeastern Minnesota and Canada appears functional based on radio-telemetry data that have documented lynx movements between Minnesota and Ontario (Burdett *et al.* 2007, p. 458; Moen 2009, pp. 4-6; Moen *et al.* 2010b, p. 5).

Lynx Status: At the time of listing, the Minnesota population was not believed to contribute significantly to the DPS. However, we now know that a reproducing resident population exists in northeastern Minnesota. Moen (*in* Lynx SSA Team 2016) recently estimated the potential for a population of about 50 to 200 lynx to occur in northeastern Minnesota. In 2008, Moen *et al.* (2008b), estimated the number of lynx that might be resident in northeastern Minnesota at a given time as between 190 and 250 individuals, assuming that about 25 percent of northeast

Minnesota is suitable lynx habitat, coupled with assumptions about residence time and detectability. The actual number of lynx is unknown because methods have not been implemented to measure and produce precise population estimates over such a large geographic area. We have no estimates of lynx densities in Minnesota.

Home range sizes in Minnesota were reported as 194 km^2 (75 mi^2) males and 87 km^2 (34 mi^2) females (Mech 1980, p.263). Later radio-collar data show that males had much larger home ranges 267 km^2 (103 mi^2) than females 21 km^2 (8 mi^2); and that females with kittens had the smallest home range (Burdett *et al.* 2007, pp. 460-461). A study of radio-collared lynx in Minnesota documented approximately 40 percent of male and female lynx making long distance movements outside of their home range between Ontario, Canada and Minnesota (Moen *et al.* 2010b, p. 17). Of those lynx that made long-distance movements, females tended to move 62-124 miles (100-200 km) and did not return to their original home range, while males moved 31-49 miles (50-80km) back and forth between Ontario and Minnesota (Moen *et al.* 2010b, p. 17). While topographic features may influence lynx movements in mountainous western states, lynx in Minnesota tended to move nearly straight paths (Moen *et al.* 2010b, p. 13).

The SNF and others have identified 268 unique individual lynx (48 percent Female, 51 percent Male) from DNA samples taken since 2000 (Catton *et al.* 2015, p. 1). Of the 1,306 DNA samples, 1,039 were identified as lynx, however 42 samples were identified as F1 lynx-bobcat hybrids (Catton *et al.* 2015, p. 1). Of those 42 hybrids, 13 unique individual lynx-bobcat genotypes (5 Female, 8 Male) were also identified (Catton *et al.* 2015, p. 1). The DNA analyses also showed persistence of individual lynx in Minnesota of 2 years (N = 27 lynx), 3 years (N = 11), 4 years (N = 5), 5 years (N = 6), and 1 female lynx tracked for over 5 years, who produced 7 kittens in Minnesota (Catton *et al.* 2015, pp. 3-5).

Since 2000 the U.S. Fish and Wildlife Service has been tracking incidental take of lynx; 29 lynx mortalities have been reported from trapping, shooting, vehicle collisions, and railroad mortalities in Minnesota. Thus far, of 26 lynx documented to have been incidentally trapped in Minnesota, 11 died and 15 were released alive (U.S. Fish and Wildlife Service, unpublished database 2016). The documented incidents largely occurred during legal trapping that targeted bobcat, coyote, fox, and marten, and involved a variety of traps including foot-holds, body gripping traps, and snares (U.S. Fish and Wildlife Service, unpublished database 2016). In addition, seven lynx mortalities as a result of being incidentally shot have been documented in Minnesota and 16 died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Lynx emigrating from Minnesota to Ontario exposes them to trapping and shooting that is allowed in accordance with regulated harvest in Canada. At least a third of the animals radio-collared in Minnesota spent time in Ontario; 4 radio-collared lynx were legally harvested (trapped) in Canada between 2003 and 2010, and two died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Furthermore, nine lynx mortalities due to vehicle collisions have been documented in Minnesota since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). Minnesota has relatively high forest road and highway densities that intersect lynx habitat and several radio-collared lynx in Minnesota inhabited home ranges that were bisected by highways. In addition to road mortalities, two railroad mortalities

have been documented since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). It is probable that there are additional incidental catches that are not reported each year (Moen 2009).

Factors Affecting Current Conditions: Identified factors affecting to the current conditions of lynx in Minnesota include reduction in habitat quality or quantity, habitat fragmentation, climate change, increased access for competing carnivores, and human-caused mortality. The SNF is currently implementing the 2004 SNF Plan (USDA 2004, entire), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the SNF has a long-term commitment for doing so; however, private landowners do not. Under the Sustainable Forest Resource Act of 1995, the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx. The implementation of the MFRC guidelines is monitored annually (e.g., MDNR 2015, entire). Thus, the several risk factors are being minimized and managed to promote the conservation of lynx within the SNF, however implementation of the guidelines on privately owned lands is voluntary.

Activities that change forest structure can affect habitat quantity and quality for lynx and snowshoe hares, their primary prey source. Thinning and other timber management practices that reduce stem density and downed material and promote more open, mature stands can reduce habitat quality and quantity. Throughout the Superior National Forest and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Mineral exploration and development is increasing in portions of Minnesota, particularly for hard rock (non-ferrous) minerals. Some of the area of interest for minerals overlaps with lynx habitat in northeastern Minnesota. Mineral exploration may result in short-term displacement of lynx. Mining activities and associated development may result in an irreversible loss of habitat or increased mortality risk. The specific effects to lynx and their habitat will depend on the scale and type of each project.

Roads are a factor in human-caused lynx mortality where they provide access to areas where lynx occur, increasing the risk of negative interactions between people and lynx. Throughout the SNF outside the BWCAW, high and low standard roads bisect many areas that provide potential or suitable lynx habitat. Additionally, bobcat harvest in northeastern Minnesota has been increasing over the last decade (Erb 2012, unpaginated). Where lynx and bobcat overlap, there is potential for accidental shooting of lynx, or for bobcat hunting with dogs to harass or harm lynx.

Snow compacts under natural conditions; however, snow compacted by human activity may increase access by coyotes and bobcats to prey in deep snow conditions where historically they were excluded or rare. Winter road use, snowmobiling, cross country skiing, and dog sledding

all have the effect of compacting snow. Outside the BWCAW, snowmobile activity is extensive and increasing significantly. The SNF has 705 miles of snowmobile trails and 1,562 miles on all ownerships within the proclamation boundary (USDA 2011). Advances in snowmobile capabilities have raised concerns about intrusion and new snow compaction in areas previously not vulnerable to high levels of snowmobile use. In addition, new road construction in lynx habitat has made more areas accessible during winter. These routes could be used by snowmobiles even if new roads are designated as closed to motorized public travel during other seasons. The SNF has 1,927 miles of low standard roads (OML 1 and 2) and 158 miles of temporary roads (USDA 2011). All of these factors have potential to reduce the deep and fluffy winter snow conditions and to reduce the competitive advantage of lynx in areas that typically receive deep snows.

As described in Chapter 2, above, lynx are adapted for surviving in areas that have cold winters with deep, fluffy snow, where they outcompete potential competitors such as bobcats, coyotes, and wolves (Buskirk *et al.* 2000a, pp. 90-91; McCord & Cardoza. 1982, pp. 748-749; Ruediger *et al.* 2000). The geographical distr bution of bobcat harvest in Minnesota has remained relatively static with a lack of harvest in the Arrowhead region of Minnesota (the region encompassed by Cook, Lake and St. Louis counties in northeastern Minnesota) (Erb 2009 cited in Kapfer 2012, p. 16, Erb 2012, pp. 7-9) and annual snow track and scent stations surveys support the conclusion that bobcats are as rare in the Arrowhead as harvest indicates (MN DNR unpublished data cited in Kapfer 2012, p. 23). However, this may change with decreased snow conditions predicted to occur due to climate change (Kapfer 2012, p. 25). Bobcat and coyote populations already appear to be increasing in Minnesota (Erb 2014, p. 40). If snow depth and duration decrease in the Arrowhead, deer mortality may be reduced which may potentially increase bobcat densities and bobcat expansion into northeast Minnesota (Kapfer 2012, p. 25). According to annual track surveys, wolf populations in Minnesota are currently stable (Erb 2014, p. 40), however, similar to bobcat, wolf populations may increase with changing snow conditions and prey availability as influenced by climate change.

Furthermore, in Northeastern Minnesota, several lynx-bobcat hybrids have been documented (Catton *et al.* 2015, p. 1), however, most bobcat records occur south and west of the core part of the lynx range in Minnesota (see figure 1.1 *in* Kapfer 2012, p. 51). Bobcat populations are increasing in Minnesota (Erb 2014, p. 40) and more bobcat-lynx hybridization may occur as a result of climate change (Koen *et al.* 2014, p. 113).

4.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Unit Description: This geographic unit includes the parts of northwestern Montana and northeastern Idaho the Service designated as critical habitat (Unit 3) for lynx in 2014 and some Tr bal and State lands that were excluded from that designation (79 FR 54825). It encompasses approximately 27,000 km^2 (10,424 mi^2) in portions of Boundary County in Idaho and Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton Counties in Montana, with ownership that is 84 percent federal (USFS,NPS, and BLM); 8 percent private; 4 percent State; and 4 percent Tribal. Most federal lands in this unit (82 percent) are on national

forests managed by the USFS; with NPS (16 percent) and BLM (almost 2 percent) contr buting most of the remainder. This unit includes most of Glacier National Park and parts of the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests, the BLM's Garnet Resource Area, and the Confederated Salish and Kootenai Tribes Flathead Reservation. It also includes (from northwest to southeast) all or parts of the Purcell, Cabinet, Salish, Whitefish, Lewis, Flathead, Swan, and Garnet mountain ranges. Several areas adjacent to this unit are known or thought to support a small number of resident lynx, at least intermittently, including the southern Selkirk Mountains of northern Idaho and northeastern Washington and the western Cabinet Mountains of northern Idaho (B. Holt 2016, pers. comm.; USFS 2015, pp. 9-10), and a small area of the Helena National Forest just south of MacDonald Pass, between Helena and Missoula (Gehman *et al.* 2011, p. 21). This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit may represent the southern extent of a larger cross-border population that also occurs in southwestern A berta and southeastern British Columbia (B.C.). Relative to other DPS lynx populations, this unit is about 200 km (125 mi) east of the north-central Washington unit, about 145 km (90 mi) northwest of the GYA, and about 1,480 km (920 mi) west of the Northeastern Minnesota geographic unit.

Habitat Description: In the Northern Rocky Mountains, most lynx occurrences are associated with the Rocky Mountain Conifer Forest or Western Spruce-Fir Forest vegetative classes (Kuchler 1964, p. 4; McKelvey *et al.* 2000a, p. 246) at elevations ranging from 1,250 m (4,100 ft) to 2,500 m (8,200 ft) (Aubry *et al.* 2000, pp. 378–380; McKelvey *et al.* 2000a, pp. 243–245). The dominant vegetation that constitutes lynx habitat in these areas is subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanii*) and lodgepole pine (*Pinus contorta*) (Aubry *et al.* 2000, p. 379; Ruediger *et al.* 2000, pp. 4-8 - 4-10). Within these vegetation types, lynx appear to prefer areas of moderate to gentle topographic relief (Koehler and Aubry 1994, p. 86; Apps 2000, p. 352; Squires *et al.* 2013, pp. 187, 191). Lynx use large landscapes that include a temporally- and spatially-shifting mosaic of forest age classes, where natural or anthropogenic disturbances may reset forest succession (ILBT 2013, p. 28). Early successional stages that often provide dense horizontal cover at ground/snow level and support high hare densities (Griffin 2004, pp. 53-54, 70; Squires *et al.* 2010, pp. 1654-1656) may be created and maintained by natural disturbance processes including wildfire, insect infestations, tree diseases, and wind events (ILBT 2013, p. 28). Timber harvest, other silvicultural treatments, wildfire management, or other vegetation management, which may be beneficial, benign, or adverse to lynx and hare habitats depending on prescription, extent, and implementation, can also influence the amount and distr bution of early successional stands (Agee 2000, p. 39; ILBT 2013, pp. 28, 71-76). Likewise, natural disturbance regimes and forest management can also influence the amount and distr bution of mature multistoried spruce-fir stands, which can include dense horizontal structure, support high hare densities (Griffin 2004, pp. 53-54, 70; Squires and Ruggiero 2007, pp. 313-314; Berg *et al.* 2012, pp. 1483-1485), and provide preferred winter foraging habitat for lynx (Squires *et al.* 2010, pp. 1653-1657).

In northwestern Montana, lynx generally occur in mid-elevation (1,260 – 2,355 m [4,130 – 7,730 ft]) moist subalpine mixed-conifer forests dominated by Englemann spruce and subalpine fir and including Douglas fir (*Pseudotsuga menziesii*), western larch (Larix occidentalis), and lodgepole

pine (Squires *et al.* 2010, pp. 1653-1654). Lynx home ranges occur in areas with low surface roughness (i.e., low topographic relief; gently-sloping to moderately-steep terrain), high canopy cover indices, and little open grassland (Squires *et al.* 2013, p. 191). These lynx habitats occur below the alpine zone and above drier, more open forest types (e.g., ponderosa pine [*Pinus ponderosa*] and dry Douglas-fir/western larch/lodgepole pine) that do not provide lynx habitat (Agee 2000, p. 42; Berg 2009, p. 20; Squires *et al.* 2010, p. 1655). As elsewhere in the western portion of the DPS, this elevational pattern contr butes, along with the transition from boreal to more temperate forests, to a naturally patchier, more fragmented distribution of lynx habitat than in the continuous boreal forest landscape in the core of the lynx's North American range in northern Canada and interior Alaska (65 FR 16052-53; 68 FR 40089; Squires *et al.* 2006[a], pp. 46-47; ILBT 2013, pp. 76-77; Squires *et al.* 2013, p. 191; 78 FR 59438). Squires *et al.* (2013, pp. 187-189) used telemetry data to model the distribution of probable lynx habitat in a 36,096-km^2 (13,937-mi^2) study area that completely overlaps this geographic unit. Their results indicate that much of the area has a low to moderate probability of selection by lynx, and that the areas with higher selection probabilities are relatively small and patchily- but widely- distributed throughout the unit and are separated by intervening areas of low probability of lynx use (Squires *et al.* 2013; see Figure 1(a), p. 189). This patchy distribution of high-quality habitats interspersed with areas of low-quality or non-habitat results in naturally lower densities of both snowshoe hares and lynx than those in the continuous boreal forests of northern Canada and Alaska (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373–375, 382, 394).

In winter in this unit, lynx preferentially use mature multistoried forest stands, predominantly spruce-fir, with dense horizontal cover, and they avoid clearcuts and large forest openings (Squires *et al.* 2010, pp. 1648, 1653–1656). In summer, lynx also select young stands with dense spruce-fir saplings, do not appear to avoid openings as in winter, and use slightly higher elevations (Ibid.). Both mature multistoried and young regenerating stands provide dense horizontal structure at ground/snow level, which supports higher snowshoe hare densities than more open young or mature forests. In the central (Seeley Lake study area) part of this unit, during an apparent regional hare decline in 1999-2001, summer hare densities were highest (up to 1.4 hares/ha in one study area) in dense young stands and winter densities were highest (up to 1.8 hares/ha in one study area) in dense mature stands (Griffin and Mills 2009, pp. 1492-1496). Over a longer interval (1999-2003) when hare populations in this area were thought to be stable (Squires and Ruggiero 2007, p. 314), mean summer and winter hare densities, respectively, were 0.34 hares/hectare (ha) and 0.53/ha in dense mature stands and 0.64/ha and 0.47/ha in dense young stands – habitats selected by lynx, compared to 0.18/ha and 0.20/ha in open mature stands and 0.18/ha and 0.12/ha in open young stands that lynx did not select (Squires and Ruggiero 2007, pp. 313-314). Even the relatively higher hare densities in the dense mature and dense young stands only marginally achieve the threshold density of 0.5/ha thought necessary to support lynx within home ranges (Ruggiero *et al.* 2000b, pp. 446–447; ILBT 2013, pp. 24, 26, 90). Nonetheless, hares accounted for 96 percent of the biomass in lynx diets in this unit based on evidence at kill sites (Squires and Ruggiero 2007, pp. 310-313), suggesting that even small declines in landscape-level hare densities could reduce the ability of habitats in this unit to support resident lynx (Squires *et al.* 2010, p. 1656).

Lynx in this unit generally den in mature spruce-fir forests among downed logs or root wads of wind-thrown trees in areas with abundant coarse woody debris and dense understories with high horizontal cover in the immediate areas around dens (Squires *et al.* 2004a, Table 3; Squires *et al.* 2008, pp. 1497, 1501–1505). Few dens are located in young regenerating or thinned stands with discontinuous canopies (Squires *et al.* 2008, p. 1497). Many dens have northeasterly aspects and are farther from forest edges than random expectation (Squires *et al.* 2008, p. 1497).

Average annual snowfall in this unit ranges from about 142 cm (56 in) in the Kalispell/ Whitefish/ West Glacier area of northwestern Montana to 183 cm (72 in) in Nordman in northern Idaho, to 216 cm (85 in) in Lincoln, Montana, near the southern end of the unit, to 259 cm (102 in) in Rexford, Montana near the Canada - U.S. border, to 345 cm (136 in) in Seeley Lake, Montana, in the central part of the unit, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 4/2/2016).

Habitat Status: Lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 84 percent (22,761 km^2 [8,788 mi^2]) of this unit is in federal ownership, including 18,695 km^2 (7,218 mi^2) in national forests under USFS management, 3,658 km^2 (1,412 mi^2) in Glacier National Park managed by NPS, and 397 km^2 (153 mi^2) managed by BLM in its Garnet Resource Area. As described above, potential lynx habitat in this unit is patchily- distributed and interspersed with areas of non-habitat (matrix). Among the six national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 54 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123). In Glacier National Park, 2,976 km^2 (1,149 mi^2; about 73 percent of the park) is considered “lynx forest types” (65 FR 16073), but only 1,103 km^2 (426 mi^2; 27 percent of the park, 37 percent of lynx forest types) is estimated to be lynx habitat (68 FR 40086, 40089). In the Garnet Resource Area, the BLM designated five LAUs (which approximate a lynx home range) covering 947 km^2 (366 mi^2), of which, 574 km^2 (222 mi^2; about 61 percent) was mapped as lynx habitat (Sparks 2016a, pers. comm.).

Federal lands are managed as either ‘‘developmental’’ or ‘‘nondevelopmental’’ land use allocations (68 FR 40093). Lands in developmental allocations are managed for multiple uses, such as recreation and timber harvest, some of which may conflict with lynx conservation. Management within non-developmental allocations focuses on the maintenance of natural ecological processes, or conservation of rare ecological settings or components, and these areas include wilderness, roadless, and semi-primitive non-motorized areas (USFWS 2007, pp. 33, 77). Timber harvest, road construction, and fire suppression typically do not occur or are very limited in lands managed in non-developmental allocations.

In this SSA unit, almost 46 percent of the federal land and 40 percent of the entire unit is in designated wilderness or national park land, including (in addition to Glacier National Park) the 6,297-km^2 (2,431-mi^2) Bob Marshall Wilderness Complex (Bob Marshall, Great Bear, and Scapegoat wilderness areas) on the Flathead, Lewis and Clark, Helena and Lolo national

forests, the 302-km^2 (117-mi^2) Mission Mountain Wilderness on the Flathead National Forest, the 139-km^2 (54-mi^2) Rattlesnake Wilderness Area on the Lolo National Forest, and the 371-km^2 (143-mi^2) Mission Mountain Tribal Wilderness on the Flathead Reservation. Management of NPS lands and both national forest and Tribal wilderness areas provides restrictions on land use beneficial to lynx (65 FR 16073; USFWS 2014, pp. 28-29; 79 FR 54831), and adverse effects of management activities on lynx habitats in these areas are unl kely. Among the six national forests that contribute to this unit, 56 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34).

Much of the remaining USFS lands and the BLM lands have developmental land-use allocations where some management activities have the potential to impact lynx or its habitat. However, as described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2004 amended the Resource Management Plan (RMP) for the Garnet Resource Area to incorporate the conservation measures identified in the LCAS (BLM 2004a, 2004b, entire; Sparks 2016b, pers. comm.). Both documents provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently- applied framework for conserving and restoring important hare and lynx habitats.

Habitat status on private lands, which account for about 8 percent of lands in this unit (2,172 km^2 [839 mi^2]), is governed by some federal and State regulations and buy a number of private-public conservations partnerships and State agency efforts. As described in section 3.1., above, some federal and State regulations guide some activities on private lands, including the ESA's prohibition on take of listed species, and State regulations governing trapping and timber management. In addition to these protections, there have been several other notable lynx conservation achievements on private lands in this unit since the DPS was listed. Two of these, the Clearwater-Blackfoot Project and the Montana Legacy Project, are multi-partner and community efforts led by The Nature Conservancy in Montana to purchase large tracts of private commercial timberlands, conveying some to the State of Montana and the USFS for conservation management, and acquiring conservation easements on others (TNC 2016a, 2016b, 2016c, entire). These land acquisitions have resulted in protection of roughly 673 km^2 (260 mi^2) of important lynx habitat within this SSA unit and another 583 km^2 (225 mi^2) just to the south and west that may occasionally or temporarily support lynx or provide dispersal habitat. Additionally, the MTFWP has acquired fee title or conservation agreements on 3,096 km^2 (1,195 mi^2) of private lands in western Montana, including 162 km^2 (63 mi^2) in designated lynx critical habitat in this SSA unit, with ongoing efforts on another 106 km^2 (41 mi^2) in the northwest part of the unit (MTFWP 2016, pp. 1, 3).

In addition to the MTFWP's efforts to acquire private lands and protect them through fee title or conservation agreement, the State of Montana has also worked to protect lynx habitat on State-owned lands, which account for about 4 percent of the lands in this unit (1,106 km^2 [427 mi^2]). As described above in section 3.1.2, the MTDNRC worked closely with the Service to develop the *State of Montana Department of Natural Resources and Conservation Forested State Trust Lands Habitat Conservation Plan* (MTDNRC HCP; MTDNRC and USFWS 2010a, 2010b, 2010c, entire); a multi-species HCP that focuses primarily on commercial forest management. The HCP includes a Lynx Conservation Strategy that minimizes impacts of forest management activities on lynx, describes conservation commitments that are based on recent information from lynx research in Montana, and commits to active lynx monitoring and adaptive management programs. The HCP covers about 2,220 km^2 (857 mi^2) of forested State trust lands in western Montana, including 703 km^2 (271 mi^2) within this SSA geographic unit (about 64 percent of State lands in this unit). The goal of the HCP's Lynx Conservation Strategy is to support federal lynx conservation efforts by managing for habitat elements important to lynx and their prey that contribute to the landscape-scale occurrence of lynx. Specific objectives to achieve this goal include protecting den sites and potential denning habitat, mapping and maintaining lynx foraging habitats and limiting the spatial and temporal scope of their conversion to unsuitable conditions from forest management activities, and providing for habitat connectivity (MTDNRC and USFWS 2010b, pp. 2-45 - 2-61). The HCP was finalized and permitted by the Service in 2011, and includes a 50-year commitment by the State to manage for lynx conservation on these lands (79 FR 54835-37).

Tr bal lands of the Flathead Reservation account for almost 4 percent of this unit. In addition to the Tribe's approach to lynx management described in section 3.2.1, above, most lynx and lynx habitat on the reservation occur in areas with formal protective status, including: (1) The long-designated Mission Mountains and Rattlesnake Tr bal Wilderness Areas, which are largely roadless and managed for wilderness qualities; (2) the South Fork/Jocko Primitive Area, which is open to use only by Tribe members and in which commercial timber harvest is prohibited; and (3) the Nine-mile Divide country, which is marginal in terms of lynx habitat, but which is also partly roadless (Courville 2014, pers. comm.; 79 FR 54831).

As elsewhere in the DPS, winter foraging habitat is thought to be the most limiting habitat for lynx in this unit (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27). As described above, lynx selected mature multistoried stands with dense horizontal structure and relatively higher winter hare densities (Squires *et al.* 2010, pp. 1648, 1653–1656). Because of this preference, the Forest Service in the NRLMD adopted a vegetation management standard (VEG S6) that precludes all vegetation management activities that could reduce winter snowshoe hare habitat in multistoried forests, not just precommercial thinning as recommended in the LCAS (USFS 2007, pp. 13-14). Also as elsewhere (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517, ILBT 2013, p. 30; 79 FR 54790), denning habitat is not thought to be a limiting factor for lynx in this unit (Squires *et al.* 2008, p. 1505). Nonetheless, the NRLMD includes guidance to ensure adequate denning habitat remains well distributed in LAUs and, therefore, across the larger landscape and to design projects to create or retain coarse woody debris in areas where denning habitat may be lacking (USFS 2007, p. 17). Snow conditions in this unit

also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America, showing that this geographic unit has a 90-95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

Overall, although naturally fragmented and patchily-distributed, lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway) development and evidence of minor genetic differentiation among lynx subpopulations (see *Lynx Status*, below), past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

A possible exception may be in the Garnet Mountains, which are known to have supported a small number of resident lynx in the 1980s and recently from 2002-2010, but where more recent surveys and research trapping efforts have failed to detect lynx (Squires *in* Lynx SSA Team 2016, p. 20; also see Lynx Status, below). This small and relatively isolated island of lynx habitat (Squires 2014, p. 4) at the southern end of this unit is thought to be capable of supporting 7-10 lynx home ranges (Squires 2016, pers. comm.). The BLM (2004, pp. 4-5) contrasted current and historical distributions of lynx habitats in the Garnets and found that early- successional stands (future hare and lynx foraging habitats) were at 25-50 percent of the historic condition in lower- elevation (1,370-1,830 m [4,500-6,000 ft]) lynx habitats, and 10-30 percent in higher- elevation (1,675-2,130 m [5,500-7,000 ft]) habitats. Late- successional (mature multistoried) stands (25-75 percent of historical condition) and large (> 100 ha [250 ac]) patches (25-50 percent of historical condition) were also underrepresented at lower elevations, but at higher elevations, late- successional stands and large patches exceeded 200 percent and 100 percent of historical conditions, respectively. Lower elevation habitats were fragmented by roads and past management practices (i.e., timber harvest), while higher-elevation habitat patterns were attributed to the absence of disturbance, including fire (BLM 2004, p. 5), though fire absence was not attributed to suppression.

As discussed for the GYA in section 2.3.2.2, above, whether the recent absence of lynx in the Garnets represents the extirpation of a previously- persistent small resident population (and, therefore, a contraction in the range of resident lynx in this unit) or a temporary “winking off” of a small peripheral population that would be expected in a mainland-island metapopulation structure is uncertain and perhaps irresolvable. If residency was intermittent historically, the current absence of lynx might be a natural condition related to the area’s naturally fragmented habitats and generally low hare densities - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. If so, future intermittent lynx occupancy would be expected, but only if lynx dispersing from a source

population immigrate to the Garnets when habitat conditions and hare densities return to more favorable levels. Conversely, if the Garnets historically supported a small but persistent population that was recently extirpated, it may suggest that the alteration of the historic distribution of some habitats in some parts of the range, descr bed above, was enough to tip the quality of the area's habitat from capable of supporting a small resident population to no longer capable of doing so.

In summary, almost all lands in this unit are managed to conserve lynx and hare habitats in accordance with federal, State, and Tribal regulations and management direction, conservation easements, and an approved HCP. Much of the area consists of designated federal and Tribal wilderness areas and other nondevelopmental land use allocations, where management activities with the potential to adversely affect lynx generally do not occur. On lands with development allocations, USFS, BLM, and State management are based on plans that incorporate the conservation guidance identified in the LCAS as informed by more recently-available scientific information. The State and TNC, working with other conservation partners, have bought or acquired conservation easements on large tracts of high-quality private lands in the unit that are known or suspected to be occupied by resident lynx. These efforts and management across multiple ownerships likely preclude landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places, as described above for the Garnet Mountains. Because lynx habitats in this unit, like most other areas of the DPS range, are naturally highly-fragmented, and most have hare densities that barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit although, as described in section 2.3.2.2 above, it is thought to be capable of supporting perhaps 200-300 lynx (Squires *in* Lynx SSA Team 2016, p. 41). This is substantially fewer than previous estimates of more than 1,000 lynx, which were based on a habitat area/ density index and broad assumptions regarding habitat suitability and lynx distribution (65 FR 16058) that are not supported by current understanding of lynx habitat requirements. As described above, habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Although the exact distribution of resident lynx remains uncertain, this unit has a long and continuous history of lynx occurrence and evidence of reproduction (McKelvey *et al.* 2000, pp. 224-225; Squires and Laurion 2000, pp. 346-348; Squires *et al.* 2008, entire; Squires *et al.* 2013, entire; ILBT 2013, p. 57; 65 FR 16058; 68 FR 40090; 74 FR 8643; 79 FR 54825). Genetic analyses revealed minor fine-scale genetic sub-structuring among lynx subpopulations in the southern (Garnets), central (Seeley Lake), and northern (Purcells) parts of this unit, suggesting limited interaction among lynx in those areas (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5; Squires *in* Lynx SSA Team 2016, p.

20). Lynx in this unit likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia, but the extent to which lynx persistence in this area may rely on immigration from Canada is unknown, and there is no indication of substantial immigration (irruptions) of lynx from Canada into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20).

From 1998 to 2007, researchers with the Forest Service's Rocky Mountain Research Station in Missoula trapped and radio-marked 175 lynx in northwestern Montana and collected nearly 170,000 GPS and over 3,000 VHS telemetry locations documenting lynx movements, resource use, survival, and productivity (Squires *in* Lynx SSA Team 2016, p. 20). From 1999-2007, litter sizes averaged 2.24 kittens/litter (N = 33) in the Seeley Lake area and from 2003-2007, 2.95 kittens/litter (N = 22) in the Purcell Mountains. In Seeley Lake, 61 percent of breeding-age females (N = 52) produced kittens; in the Purcells, 83 percent of females (N = 28) produced kittens. Recent research (Kosterman 2014, entire) suggests that the probability that a female produces a litter and initial litter size are correlated positively with mature forest connectivity and negatively with fragmentation in female home ranges (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix A). Annual survival rates for subadult and adult female lynx were 0.52 and 0.75, respectively, in Seeley Lake, and 0.68 and 0.85, respectively, in the Purcells. There was no evidence of cyclicity in these vital rates, and no indication of substantial immigration of lynx into these study areas from Canada. Starvation, predation by mountain lions, and human-caused deaths each accounted for roughly one-third of documented sources of lynx mortality. Population viability analyses yielded population growth rates (λ) of 0.92 for the Seeley Lake area (i.e., declining population trend, 1999-2007) and 1.16 for the Purcells (increasing trend, 2003-2007). However, as described in section 2.2.2, above, estimates of λ in a cyclic Canadian population of lynx ranged from 2.03 (annual doubling) when hares were abundant to 0.10 (order of magnitude decline) after hare populations crashed (Slough and Mowat 1996, p. 952, Table 4), and the natural range in λ that would be expected among peripheral, isolated, or semi-isolated and non-cyclic or weakly-cyclic lynx populations in the DPS versus those that would signal long-term population decline or instability is unknown.

As described above, lynx distribution in this unit may have contracted with the recent apparent disappearance of resident lynx from the Garnet Mountains in the southern part of the unit. Lynx were documented in the Garnets in the 1980s and from 2002-2010, but no lynx were detected during snow-track and camera-trap surveys in winter 2014-2015 (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix 5). This area is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.); 5 lynx were monitored via telemetry in 2002, 3 in 2003-2004, 2 in 2005, and single lynx each year in 2006, 2007, and 2010 (Squires *in* Lynx SSA 2016, Appendix 5 [2015 10 14 - 8, p. 26]). As described in section 2.3.2.2 and above, whether the recent absence of lynx from this part of the unit represents the extirpation of a small but previously persistent population (and, therefore, a permanent contraction of lynx distribution in this unit) or the temporary "winking off" of a peripheral subpopulation that may become "winked on" again in the future is unknown and perhaps irresolvable.

Snow-tracking, hair-snare, and camera-trap surveys in other parts of this unit since the DPS was listed continued to detect lynx on the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests (USFS 2015, pp. 9-27). On the Flathead, the USFS Rocky Mountain Research Station(RMRS) trapped and radio-marked 7 lynx (3 females, 4 males) in the Flathead River watershed from 2010-2015, and surveys detected lynx in several other areas including the Salish Mountains, the area just south of Glacier National Park, and in the vicinity of Hungry Horse Reservoir (USFS 2015, pp. 10-11). The Swan Lake District in the southern part of the Flathead, along with the Seeley Lake District of the Lolo National Forest and the Lincoln District of the Helena National Forest, is part of the 6,070-km^2 (2,344-mi^2) Southwestern Crown of the Continent, which was intensively surveyed from 2012-2014 by the Southwestern Crown Carnivore Monitoring Team (SCCMT 2014, entire). The SCCMT conducted snow track surveys and used hair snares, bait stations, and camera traps to detect lynx in 36 of the 82, 8 x 8 km (5 x 5 mi) grid cells they surveyed (SCCMT 2014, pp. 3, 17-20). The surveys resulted in collection of DNA that allowed identification of 18 individual lynx (5 females, 13 males), 13 of which were new to regional lynx databases (SCCMT 2014, pp. 3, 17-20).

On the Helena National Forest, few lynx have been detected outside the Lincoln District/ Southwest Crown descr bed above. In the south MacDonald Pass area, just south of this SSA unit and south of designated critical habitat, an individual male lynx was verified by DNA evidence over four winters (2007-2011), and an individual female was verified in the same area in the winter of 2008-2009 (Gehman *et al.* 2011, p. 21; USFS 2015, p. 27). Other surveys on the Helena failed to detect lynx in the disjunct Big Belt and Elkhorn Mountains, although telemetry data indicated that three lynx released in Colorado passed through the Big Belts in 2004-2006 (USFS 2015, pp. 26-27). Likewise, during snow tracking surveys on the Lolo in 2010-2011 (prior to the Southwestern Crown monitoring described above), lynx were also confirmed on the Seeley Lake District in the eastern part of the forest, but no lynx were documented on the Missoula or Ninemile districts, nor on the Superior and Plains/Thompson Falls districts in the western part of the forest (USFS 2015, pp. 12-14). The USFS concluded that lynx presence in districts other than Seeley Lake is extremely rare and likely represents occasional dispersing lynx (USFS 2015, p. 21).

On the Kootenai National Forest, RMRS research efforts continued to document the long-term presence of lynx, where trapping and radio-marking efforts yielded 50,000-60,000 lynx telemetry locations from 2003-2012 (USFS 2015, p. 10). On the Lewis and Clark National Forest, lynx are considered “still present” in the Rocky Mountain Front portion of the forest, which is within this geographic unit and designated critical habitat, and snow track surveys from 2010-2013 in the disjunct Little Belt and Crazy Mountains documented the continued absence of resident lynx in those ranges (USFS 2015, pp. 25, 27-34). On the Idaho Panhandle National Forest, surveys detected individual lynx in the Selkirk Mountains in 2010 and 2011 and in the Purcell Mountains in 2012. All detections were within 15 miles of the Canada-U.S. border (USFS 2015, p. 10). No lynx were detected during surveys in 2007 or 2013-2014, and snow surveys were not done in 2015 because of poor snow conditions (USFS 2015, p. 9). However, in 2012-2014 three lynx were incidentally trapped on the Idaho Panhandle (one in 2012 in the Purcells, and two in 2014

in the Cabinet Mountains), and another was documented by a Service grizzly bear trapping crew in the Purcells in 2014 (USFS 2015, pp. 9-10; U.S. District Court ID 2016, pp. 6-7).

In summary, although the number of lynx in this geographic unit is uncertain, resident lynx appear to remain broadly distributed throughout most of the unit. The recent apparent absence of lynx in Garnet Mountains may indicate extirpation of a small resident population and a contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure. Lynx are rarely detected on surveys on other national forests (or parts of those above) that are outside but adjacent to this geographic unit (Patton 2006, entire; USFS 2105, pp. 1-9, 25-34), suggesting that these areas lack the habitat features and/or landscape-level hare densities necessary to support resident lynx populations (79 FR 54818-54820).

Factors Affecting Current Conditions: *Regulatory Mechanisms* - Federal management activities (especially timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. For example, as described above in *Habitat Status* and *Lynx Status*, past timber harvest/management and associated road construction may have fragmented, reduced the amount, and altered the distribution of lynx habitats in the Garnet Mountains, perhaps contributing to the apparent recent loss of that area's ability to support resident lynx.

Currently, as described above and in section 3.1, all federal and Tribal lands, most State lands, and large blocks of private or formerly-private land in this unit are managed for the conservation of lynx habitats, and much of the unit is in designated wilderness or other nondevelopmental land-use allocations. Regulatory mechanisms and conservation measures associated with these management strategies are intended to conserve and restore lynx and hare habitats across large landscapes and multiple ownerships. Although their effectiveness has not be quantitatively evaluated, and despite the potential extirpation of a small population in the Garnets, lynx habitats and resident lynx appear to remain well distributed throughout most of this unit.

Other regulations prohibit lynx trapping and require measures to reduce the l kelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, 16 lynx are documented to have been incidentally trapped in Montana, with 13 of those occurring before 2008, when more protective regulations were put in place (MTFWP 2016, pp. 5-10). Of the 16, eight were released uninjured, one was released with an injury, and seven were killed; all incidences of mortality occurred prior to 2008 and the implementation of the more protective regulations (MTFWP 2016, p. 5). In Idaho, in addition to the three lynx incidentally trapped on the Idaho Panhandle National Forest from 2012-2014 (described above under *Lynx*

Status), one other lynx was incidentally trapped in 2012 on the Salmon-Challis National Forest further south (U.S. District Court ID 2016, p. 6).

Although lynx are legally trapped in Canada adjacent to this unit in southern Alberta and southern British Columbia, trapping there is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Environment Canada 2014, entire; Vashon 2015, pp. 5-6). Lynx harvest in Alberta varied from about 4,000 to 14,000 annually in the late 1970s and early 1980s, but declined to fewer than 2,000 for most years from 1984-2000, and restrictive quotas and season closures were implemented beginning in the late 1980s (Poole and Mowat 2001, pp. 16, 28). Similarly, harvests in British Columbia peaked at over 12,000 in the early 1960s and over 8,000 in the early 1970s, then declined to fewer than 2,000 for most years from the mid-1980s until the year 2000 (Hatler and Beal 2003, p. 2). Whether, and if so to what extent, trapping in Canada may influence lynx dispersal across the border and into this geographic unit is unknown; however, such dispersal was documented historically when harvest levels in Canada were much higher than under current management.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Hall and Fagre 2003, entire; Mote 2003, entire; Fagre 2005, entire; Knowles *et al.* 2006, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Squires *in* Lynx SSA 2016, p. 20; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities, even in areas considered high-quality habitat for this DSP unit, often appear to barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 90-95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et*

al. 2010. pp. 607, 609). Although insect outbreaks have affected some parts of the DPS, no major outbreaks have been documented in lynx habitats in this unit (Lynx SSA Team 2016, p. 41).

Vegetation Management - As elsewhere in the DPS range, timber harvest and related vegetation management (precommercial thinning and other silvicultural techniques designed to optimize forest products outputs; ILBT 2013, pp. 71-72) are the dominant land uses potentially affecting lynx habitats in this unit (68 FR 40075, 40092; 79 FR 54825). As descr bed in section 3.3, above, these activities can reduce hare and lynx habitats by reducing horizontal cover and altering natural disturbance regimes and forest successional patterns. In this unit, precommercial thinning was shown to reduce short-term hare abundance (Griffin and Mills 2007, entire) and appeared to influence lynx movements (Squires *et al*. 2013, p. 192-194), and lynx rarely traveled across recent clearcuts or other large openings, especially in winter (Squires *et al.* 2010, p. 1654; ILBT 2013, p. 77). However, as described under *Habitat Status*, above, these activities on federal lands, which account for most of the lands in this unit, occur only on lands with developmental allocations and historically appear to have impacted only a small proportion of potential lynx habitats in this unit (65 FR 16072; 68 FR 40093). Additionally, timber harvest levels on federal lands in the West, including the Northern Rockies, and specifically with regard to “lynx forest types,” had declined consistently and dramatically for a decade or longer prior to the DPS being listed (68 FR 40093), and have remained at levels much lower than those from most of the previous century. Despite some likely localized impacts, past vegetation management does not appear to have broadly diminished this unit's ability to support resident lynx, although, as described above, it may have contributed to the current absence of a small number of resident lynx from the Garnet Mountains. Also as descr bed above, current vegetation management in this unit on all federal, most State and Tribal, and some private lands, is conducted in accordance with formally amended USFS and BLM management plans, an approved State HCP, Tribal regulations, and conservation easements designed to avoid or minimize impacts to lynx habitats, especially important hare and lynx winter foraging habitats.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, where about 15 percent (4,172 km^2 [1,611 mi^2]) of the unit has burned from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20), likely in response to climate warming and related increases in drought conditions (e.g., Harvey *et al.* 2016, entire; Westerling 2016, entire). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit’s ability to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction. In the Northern Rocky Mountains, the forests upon which lynx depend have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and

these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx (with the poss ble exception of the Garnet Mountains). Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Idaho (1) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unl kely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. This unit is directly connected to lynx habitats and populations in southwestern Alberta and southeastern British Columbia, where lynx habitats are also (like Montana and Idaho) patchily-distr buted and generally support low hare densities, and where some lynx populations may be ephemeral and the persistence of others reliant on periodic influx of immigrants (Apps 2007, pp. 81, 95-104). Additionally, connectivity between this geographic unit and lynx habitats and populations in southern Alberta and southern British Columbia may be facilitated by only a few predicted corridors that extend south from the international border (Squires *et al.* 2013, pp. 187, 191-193).

Although lynx occurrence and harvest records in this geographic unit reflect the unprecedented irruptions of lynx from Canada into the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 224-226, 232-242), there is no evidence of irruptions of lynx into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). This is supported by lynx trapping records from Canada, which suggest that the magnitude of lynx populations cycles in Alberta and British Columbia dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Poole and Mowat 2001, p. 28; hatler and Beal 2003, p. 2; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which would be expected to alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a

gradual decline of a resident lynx population that needs but is not receiving adequate immigration. In contrast, the growth rate estimated for the lynx population in the Purcell Mountains in the northwestern part of this unit (λ = 1.16, increasing trend 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) suggests that the level of immigration, if necessary for demographic stability, has been adequate or that productivity and recruitment have been high enough to offset potentially diminished immigration. It is also possible that, despite the documented historical intermittent (cyclic) influxes of lynx from Canada into lynx populations in this geographic unit, immigration does not contribute meaningfully to the demographic stability of these populations. If that is the case, the estimated growth rates suggest that recruitment has failed to offset mortality in the Seeley Lake population but that it has more than done so in the Purcell Mountains population.

4.2.4 Unit 4 - North-central Washington

Unit Description: This geographic unit is located in the northern Cascade Mountain Range of north-central Washington in portions of Chelan and Okanogan Counties and includes mostly Okanogan-Wenatchee National Forest lands as well as BLM lands in the Spokane District that were designated as critical habitat (Unit 4) for lynx in 2014 (79 FR 54825). The unit also includes State Forest lands (portion of the Loomis State Forest) that were excluded from designation as critical habitat (79 FR 54825). It encompasses approximately 5,176 km^2 (1,988 mi^2), with ownership that is 91.5 percent federal (USFS, BLM), 8.2 percent State, and 0.3 percent private lands; there are no Tribal lands. This area was occupied at the time lynx was listed and is currently occupied by the species. Evidence from recent research and DNA analysis shows lynx distributed within this unit, with breeding being documented. Although researchers have fewer records in the portion of the unit south of Highway 20, this area contains boreal forest habitat and the components essential to the conservation of the lynx. Further, it is contiguous with lynx habitat north of Highway 20, particularly in winter when deep snows close Highway 20. The northern portion of the unit adjacent to the Canada border also appears to support few recent lynx records; however, it is designated wilderness, so access to survey this area is difficult. This northern portion contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia directly north of this unit.

As it is throughout the range of lynx in the contiguous U.S., maintaining connectivity with Canada is important to lynx populations in northern Washington and the Cascade Mountains. Singleton *et al.* (2002, entire) evaluated landscape permeability for large carnivores in Washington. They reported broad landscape permeability for lynx between the Thompson River watershed in British Columbia and the U.S. portion of the northern Cascades (Singleton *et al.* 2002, p. 46). According to the LCAS, connectivity currently appears functional, as lynx dispersal from Washington into Canada was recently documented. A male lynx radio-collared in 2008 in the Loomis State Forest remained there until late winter in 2009, when it dispersed north into Canada toward Hope, British Columbia, and then headed north-east toward Kamloops where it appeared to establish a home range just southeast of Kamloops. This individual was later

trapped and killed in British Columbia, highlighting the need for cooperation and shared management goals across political boundaries (LCAS 2013, p. 65).

Several areas adjacent to this geographic unit (e.g., Kettle Range, the Wedge, Little Pend Oreille, Se kirk Mountains of northeast Washington) are known or thought to support a small number of lynx, at least intermittently. One of these areas in particular (Kettle Range) contains the second largest block of potential lynx habitat in Washington comprising approximately 987 km^2 (381 mi^2), which is significantly smaller than the North Cascades that supports approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (Stinson 2001, p. 18). Historically, although the Kettle Range supports a fairly small block of lynx habitat (relative to other geographic areas supporting persistent lynx populations), it was considered to be a stronghold for lynx in Washington (Stinson 2001, p. 14). The Kettle Range was suspected to have supported a resident population until about 30 years ago when over-trapping may have resulted in their extirpation from the mountain range (Koehler *et al.* 2008, p.1523). For example, lynx were consistently trapped in the Kettle Range in the 1960s, 1970s, and 1980s. In the Kettle Range, a total of 81 lynx were trapped from 1961 through 1986. One lynx was harvested in 1963, 3 in 1966, 7 in 1967, 2 in 1969, 26 in 1970, 14 in 1976, and 17 in 1977. A single lynx was taken each year in 1980, 1983, 1985, and 1986 (Stinson 2001, p. 63). Prior to 1961, lynx trapping records were not maintained in Washington. Beginning in 1978, trapping seasons in Washington for lynx were reduced to one month. In 1987 a restricted permit system was implemented, and in 1990 a statewide closure on lynx trapping was implemented (Service 2008).

Lynx habitat in the Kettle Range is limited in size and capable of supporting few lynx. According to Koehler *et al.* (2008, p. 1523), the Kettle Range could support between 10 to 23 lynx based upon a lynx density of 2.3 lynx/100km^2 and 400 km^2 (154 mi^2) to 987 km^2 (381 mi^2) of lynx habitat. It should be noted that the lynx density estimate was derived from research conducted in the Cascade Range within a large area of contiguous, high quality habitat (Koehler 1990, pp. 845, 847). Lynx habitat in the Kettle Range is much smaller and likely more fragmented, and thus may not be capable of supporting a density of 2.3 lynx/100 km^2. The Kettle Range is also somewhat isolated from other lynx habitats in Washington (e.g., the Cascades) and British Columbia. The Kettle Range is separated from the Cascades in Washington by low elevation valleys dominated by shrub-steppe and Douglas-fir and ponderosa pine forests (Koehler *et al.* 2008, p. 1523), and from British Columbia by the Kettle River Valley (Stinson 2001, p. 20) and a major highway corridor with associated fence in British Columbia (Koehler *et al.* 2008, p. 1523). These natural topographic and anthropogenic features may present impediments to lynx movement between the Kettle Range and the Cascades and British Columbia, making natural recolonization of the Kettle Range by lynx difficult. Thus, it may be difficult for lynx to reestablish a persistent and viable resident breeding population in the Kettle Range.

Habitat Description: In the northern Cascades most lynx occurrences are associated with the Rocky Mountain Conifer Forest (Aubry *et al.* 2000, p. 379; McKelvey *et al.* 2000, p. 246) at elevations between 1,400 m (4,593 ft) and 2,150 m (7,053 ft) (McKelvey *et al.* 2000, p. 322; Stinson 2001, p. 9). Within this area lynx primarily use forests dominated by Engelmann spruce,

subalpine fir, or lodgepole pine on mild to moderate slopes (less than 30 degrees), and avoid Douglas-fir and ponderosa pine forests, forest openings, recently burned areas with sparse canopy and understory cover (less than 10 percent), low elevations [less than 915 m (3,000 ft)], and steep slopes (greater than 30 degrees) (Koehler *et al.* 2008, pp. 1518, 1521; Maletzke 2004, pp. 16-17). Similar to the northern Rocky Mountains, lynx habitat in the Cascades is naturally fragmented (Koehler *et al.* 2008, p. 1523). Disturbance is common in boreal forests, and fires and insect epidemics are major drivers of this disturbance, but other factors including wind and disease also contribute to the process of disturbance (Agee 2000, p. 47). Fire return intervals in the north Cascades ranges between approximately 100 to 250 years (Agee 2000, p. 50).

Snowshoe hares are the primary prey of lynx throughout their range in North America (Mowat *et al.* 2000, p. 267) comprising 35-97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Lynx also consume other prey species, including red squirrels, mice, voles, grouse, ptarmigan, and other species of mammals and birds, especially during summer or when snowshoe hare population densities decline (Mowat *et al.* 2000, pp. 267-268). Koehler (1990, p. 848) found snowshoe hares were the primary prey of lynx in the north Cascades of Washington occurring in 23 of 29 (79 percent) lynx scats examined, but the remains of red squirrels were identified in 7 of the 29 (24 percent) lynx scats, as were the remains of other species including deer and mice. Von Kienast (2003, p. 39), who also conducted a lynx study in the north Cascades of Washington, found snowshoe hares in 87% (40 of 46) of lynx scats, while red squirrels were identified in 28% (13 of 46) of lynx scats.

Results of lynx research in the northern portion of its range suggest that a minimum density of 0.5-1.0 hares/ha (0.2-0.4 hares/ac) is needed to support lynx reproduction, but it is unknown if a similar snowshoe hare density is required to support lynx reproduction in the southern portion of its range (Ruggiero *et al.* 2000b, p. 446). In the northern portion of lynx range (i.e., the taiga) peak snowshoe hare densities regularly exceed 4-6 hares/ha (1.6-2.4 hares/ac), and cycle as low as 0.1-1 hares/ha (0.04-0.4 hares/ac) (Hodges 2000, pp. 119-120). In the southern portion of lynx range (e.g., the U.S.) snowshoe hare densities are low compared to those in northern regions (Aubry *et al.* 2000, p. 375). Walker (2005, p. 20) estimated an average snowshoe hare density of 0.89 hares/ha (0.36 hares/ac) with a range of 0.03 to 4.85 hares/ha (0.01 to 1.94 hares/ac) in north central Washington (i.e., the Cascades). The Washington Department of Natural Resources (WADNR) found snowshoe hare densities between 0.3 and 0.7 hares/ha (0.1 and 0.3 hares/ac) on the Loomis State Forest (WADNR 2006, p. 87).

Lynx distribution is nearly coincident with the distribution of snowshoe hares (McCord and Cardoza 1982, entire; Bittner and Rongstad 1982, entire), and lynx occupy habitats where snowshoe hares are abundant (Koehler and Aubry 1994, p. 84). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448). Average annual snowfall is consistent throughout this unit and is approximately 291 cm (114.5 in) (https://snowfall.weatherdb.com/d/a/Washington; accessed 4/27/2016).

Habitat Status: The range of lynx in the contiguous U.S. is broadly delineated by the distribution of the southern extensions of boreal forest. However, the complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with naturally dynamic habitat, make it difficult to precisely delineate the historic range of lynx in the U.S. (68 FR 40084). McKelvey *et al.* (2000, pp. 245-246) described the historic range of lynx in the western U.S., encompassing at least 75 percent of lynx occurrences, as associated with the Rocky Mountain Conifer Forest containing the primary vegetation types of Douglas-fir and western spruce/fir forests. These western spruce fir forests represent the southern extension of boreal forests into the U.S. (Agee 2000, pp. 40-42, 46). The amount of boreal forest habitat in the contiguous U.S. has not changed substantially in the past 100 years (68 FR 40085).

However, while the boreal forest may not have changed substantially within the past 100 years (i.e., permanent or long-term reductions in the quantity or size), it is naturally dynamic with fire and insects representing major disturbance processes (Agee 2000, p. 47) that can create areas temporarily unsuitable for lynx through regeneration of forested stands to early successional conditions (Agee 2000, pp. 62-63). In 2001, the Washington Department of Fish and Wildlife (WDFW) estimated there was approximately 8,923 km^2 (3,445 mi^2) of potential lynx habitat within this geographic unit. Several wildfires affected lynx habitat in the north Cascades during the middle 1990s and early 2000s: 1994 Whiteface Burn (1,554 ha (3,840 ac)); 1994 Thunder Mountain Fire (3,686 ha (9,108 ac)); 2001 Thirty-Mile Fire (2,565 ha (6,338 ha)); and 2001 Farewell Fire (32,278 ha (79760 ac)) (Vanbianchi 2015, p. 23). Subsequent to these fires and incorporating new science on lynx habitat use, Koehler *et al.* (2008, pp. 1521-1522) estimated this geographic unit contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on studies conducted from 2002 through 2004. More recent wildfires, including the 2006 Tripod Fire (70,644 ha (175,656 ac)) (Vanbianchi 2015, p.23), have affected approximately 1,000 km^2 (386 mi^2) of lynx habitat within this geographic unit (Lynx SSA Team 2016, p. 21). Cumulatively, over the past 2 decades these wildfires have burned greater than 50 percent of the suitable lynx habitat within this geographic unit (Koehler *et al.* 2008, p. 1523). These acres are expected to regenerate back into suitable lynx habitat, but it may take several decades for this to occur.

Lynx Status: In Washington, there is little information on the status of the lynx population prior to the early 1960s (Stinson 2001, p. 13). From 1960-61 to 1990-91 a total of 234 lynx were harvested in Washington, with the most lynx trapped in Ferry County (35 percent of the 234), followed by Okanogan (23 percent) and Stevens (10 percent) counties (Stinson 2001, p. 13). The WDFW identified six lynx management zones (LMZs) in Washington: Okanogan, Vulcan-Tunk, Kettle Range, The Wedge, Little Pend Oreille, and Salmo-Priest (i.e., essentially the Selkirk Mountain Range in northeast Washington (Stinson 2001, p 14). In 2001, the WDFW considered lynx to be present in the Okanogan, Kettle Range, Little Pend Oreille, and Salmon-Priest LMZs; at that time lynx had not been detected in the Wedge LMZ since 1987 nor the Vulcan-Tunk LMZ since 1990 (Stinson 2001, p.15).

In 2001, based on data collected from lynx telemetry studies conducted in the Cascade Range during the 1980's, the WDFW estimated that Washington contained approximately 12,579 km^2 (4,857 mi^2) of lynx habitat which could theoretically support up to 238 lynx (based on a lynx

density of 2.5 lynx/100 km^2) (Koehler 2008, p. 1518; Stinson 2001, p. 16). However, based on professional opinions of individuals knowledgeable about lynx and lynx habitat, the WDFW adjusted this number down suggesting that Washington likely supported fewer than 100 individual lynx (Stinson 2001, p. 16). More recently, Koehler *et al.* (2008, p. 1523), estimated there was approximately 3,800 km^2 (1,467 mi^2) of lynx habitat in Washington potentially supporting up to 87 lynx. This more recent population estimate was based on a study investigating lynx habitat use in the Okanogan from 2002 to 2004, and used a lynx density estimate of 2.3 lynx/100 km^2 derived from a radio-telemetry study conducted on lynx in the Cascades from 1985-1987 (Koehler 1990, pp. 845-847). However, the study area in which the 2.3 lynx/100 km^2 density estimate reported by Koehler (1990, p.847) was derived is located in an area of the northern Cascades known as the "Meadows". During the time of Koehler's (1990, entire) study the Meadows provided some of the best lynx habitat in Washington, whereas most other lynx habitat in Washington is lower in elevation and more highly fragmented (Walker 2005, pp. 3, 6). Thus, the lynx densities Koehler observed in his study area in the Meadows may not translate to lynx densities throughout the rest of lynx habitat in Washington, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines. Thus, applying Koehler's estimated lynx density uniformly throughout Washington, may overestimate the overall lynx population capable of being supported in Washington.

Relative to the Okanogan LMZ (i.e., the north Cascades), which supports the only known persistent breeding population of lynx in Washington State, in 2001, the WDFW estimated the LMZ could support a maximum of 149 lynx (Stinson 2001, p. 16). This number was derived by estimating that the LMZ contains approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (which was decreased by 33 percent to account for unsuitable areas) combined with an average lynx population density estimate of 2.5 lynx/100km^2 derived from two studies conducted in the 1980s (Stinson 2001, p. 16). The estimated quantity of lynx habitat was based on mapping areas supporting the forest-type and physiographic characteristics identified as being used by lynx during telemetry studies conducted in the 1980s (Koehler *et al.* 2008, p. 1518), irrespective of the current condition (successional stage, or stand type, structure, or age, etc.) of the habitat. The estimation of lynx habitat was based purely on forested areas potentially supporting a forest-type potential of subalpine fir/Engelmann spruce, and the physiographic characteristics of elevations greater than 1,400 m (4593 ft) on mild to moderate slopes (Koehler *et al.* 2008, p. 1518), and did not consider whether the area was recently burned, harvested, etc. Recognizing that new information on lynx and snowshoe hare habitat use patterns had been learned since the 1980's, and that several large, stand-replacing fires had burned in lynx habitat, Koehler *et al.* (2008, entire) conducted a lynx telemetry study in the Okanogan from 2002 to 2004 to reassess the suitability of lynx habitat. They estimated that the Cascades contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on mapping areas supporting Engelmann spruce/subalpine fir forests with moderate canopy cover on flat to moderate slopes at elevations from 1,525 m (5003 ft) to 1,829 m (6000 ft) (Koehler *et al.* 2008, pp. 1521-1522). Therefore, at that time and using Koehler's (1990, p. 847) lynx density estimate of 2.3 lynx/100 km^2, the Cascades could theoretically support approximately 55 individual lynx.

From 1985 to 1987, the movements of five adult male and two adult female radio-collared lynx were monitored by Koehler (1990, entire) in the Cascades of north-central Washington. During the study two kittens were also captured and ear-tagged (Koehler 1990, p. 847). Results of the study indicated female average home range size was 39 km^2 (15 mi^2) and average male home range size was 69 km^2 (27 mi^2). Based on occupancy of the 640 km^2 study area by 15 adult lynx, adult lynx density was estimated to be 2.3 adults/100 km^2. Annual adult survival rates of the radio-collared lynx were 0.73 in 1986 and 1.00 in 1987, and kitten mortality was high at 88 percent with only 1 of 8 known kittens surviving its first year (Koehler 1990, p. 847).

As stated previously, fire is a common disturbance factor in boreal forests (Agee 2000, p. 47). Fire return intervals within western subalpine fir forests in the Cascades range from 109 to 250 years (Agee, 2000, p. 50) with typically high fire intensities in lynx habitat resulting in extensive areas of regenerating forest (Agee, 2000, p. 53). Maletzke assessed the effects of recent fires in the Cascades and their potential impacts to the lynx population there as follows:

> "From 1990-2002, there were about 2,600 km^2 of lynx habitat in the Okanogan (Eastern Cascades) area, and female home ranges were estimated at 39 – 41 km^2, suggesting the potential to support roughly 90-115 resident females (home ranges include "matrix" or non-habitat). By 2014, habitat had been reduced by fire to about 1,600 km^2, and habitat loss and fragmentation resulted in female home ranges increasing to an estimated 91 km^2, with a potential to support roughly 27 resident females" (Lynx Workshop Report 2016, p. 21).

Therefore, using Maletzke's method and assuming a 2:1 sex ratio of females to males, the total theoretical lynx population that may have been supported in the Cascades prior to 2002 may have ranged between 135 and 172 individual lynx. Subsequent to the fires the total theoretical lynx population potentially supported in the Cascades has been reduced to approximately 40 individual lynx, which potentially represents a 70 percent to 77 percent decline in the lynx population. Note: while the area (lynx habitat in the Cascade range) used to generate the population estimate of 55 lynx in the Cascades prior to the fires based on Koehler's (1990, p. 847) lynx density estimate is the same as the area used by Maletzke to generate his population estimate of 90 – 115 resident females based on simulated female home ranges with an empirically derived size and arbitrary minimum threshold of habitat, the two dissimilar population estimates used differing methodologies, and thus the population estimates themselves are not comparable. However, using Koehler's lynx density estimate of 2.3 lynx/100 km^2 and applying it to the 1,600 km^2 of lynx habitat remaining after the fires results in an estimated lynx population of approximately 37 individual lynx, which represents an approximate 33 percent reduction in the lynx population. Further informing the effects of these recent fires in the Cascades on lynx habitat is illustrated by evaluating the average size of a female lynx home range prior to and after the fires. Prior to the fires, Koehler (1990, p. 847) estimated an average female lynx home range size of 39 km^2 (15 mi^2), whereas after the fires Maletzke estimated the average female home range size had increased to 91 km^2 (35 mi^2) (Lynx Workshop Report 2016, p. 21). The important point is the recent large, stand replacing fires in the Cascades has resulted in significant temporary losses of lynx habitat, and thus the ability of the Cascades to support a persistent and viable reproducing lynx population may have been significantly impacted. The

areas impacted by these recent fires are expected to regenerate into suitable lynx habitat, but it may take 35-40 years to do so (Lynx Workshop Report 2016, p. 21).

Factors Affecting Current Condition: In 1993, lynx were classified by the Washington Fish and Wildlife Commission as a state threatened species (Stinson 2001, p. 22). On July 12, 2016, the WDFW recommended that the Washington Fish and Wildlife Commission uplist the lynx from a state threatened to a state endangered species (WDFW 2016, p.1). According to the Draft Washington State Periodic Status Review for the Lynx, the WDFW recommended listing the lynx as endangered due to: 1) observed range contraction in Washington following protection efforts; 2) the substantial loss of habitat in the last 20 years; and 3) the ongoing and anticipated threats to lynx population persistence.

Within Washington, the vast majority of lynx habitat is administered by the Okanogan/Wenatchee (OWNF) and Colville (CNF) National Forests. The North Cascades (aka the Okanogan LMZ in north-central Washington), which supports the only known, long-term persistent lynx breeding population in Washington, and within which critical habitat was designated for lynx in 2014 (79 FR 54782), is administered by the OWNF. Subsequent to listing lynx under the ESA, the Forest Service entered into a Conservation Agreement (CA) with the Service in 2000 (USFS and USFWS 2000, entire), which was revised and extended in 2006 (USFS and USFWS 2006, entire). The CA committed the ONWF and CNF to use the Lynx Conservation Assessment and Strategy (LCAS) for management of lynx and its habitat on their ownerships, and will remain in place until the forests amend or revise their individual LRMPs.

The LCAS, which was also developed pursuant to the listing by an interagency team comprised of USFS, BLM, Service, and NPS personnel, identified four primary risk factors potentially exerting population level effects upon the status of lynx: climate change, vegetation management, wildland fire management, and habitat fragmentation. To promote conservation of lynx and its habitat, the LCAS contains conservation measures addressing the identification and maintenance of lynx habitat (foraging, denning, and connectivity habitats) on federal lands. Toward this end, the LCAS recommends that federal land managers identify and map lynx habitat on their ownerships, and delineate LAUs containing the mapped lynx habitat, within which the effects of management actions on lynx habitat will be monitored and analyzed. The LCAS also recommends that the size of LAUs should be based on the average size of a female lynx home range and contain year-round habitat components (i.e., foraging and denning habitat). Thus, in Washington, and the north Cascades specifically, it appears that the single threat for which lynx were listed under the ESA (i.e., inadequacy of regulatory mechanisms) has largely been addressed through the development of the LCAS, and CA between the Forest Service and Service which commits the Forest Service, specifically for Washington the OWNF and CNF, to use the LCAS in the management of lynx habitat on their ownerships and when designing and implementing projects within LAUs.

The WADNR manages approximately 4 percent of the lynx habitat within portions of each of the delineated LMZs (WADNR 2006, p.9) in Washington State, including the Loomis State Forest that is located in the north Cascades of north-central Washington within the Okanogan LMZ. In

1996, the WADNR developed and implemented a Lynx Habitat Management Plan (1996 Lynx Plan) in response to listing of the lynx as a state threatened species by Washington State (WADNR 1996, entire). Subsequent to federally listing the lynx as threatened under the ESA, in 2006 the WADNR implemented a modified Lynx Habitat Management Plan (2006 Lynx Plan) incorporating new science into its 1996 Lynx Plan pertaining to lynx management (WADNR 2006, entire). Among other things, the WADNR 2006 Lynx Plan contains management standards and guidelines to avoid the incidental taking (as defined by the ESA) of lynx. These standards and guidelines address maintenance of lynx denning and foraging habitat, as well as habitat connectivity within and between LAUs and lynx populations within Washington (i.e., LMZs) and Canada.

For example, the WADNR 2006 Lynx Plan includes, among other things: (1) Encouraging genetic integrity at the species level by preventing bottlenecks between British Columbia and Washington by limiting size and shape of temporary non-habitat along the border and maintaining major routes of dispersal between British Columbia and Washington; (2) Maintaining connectivity between subpopulations by maintaining dispersal routes between and within zones and arranging timber harvest activities that result in temporary non-habitat patches among watersheds so that connectivity is maintained within each zone; (3) Maintaining the integrity of requisite habitat types within individual home ranges by maintaining connectivity between and integrity within home ranges used by individuals and/or family groups; and (4) Providing a diversity of successional stages within each LAU and connecting denning sites and foraging sites with forested cover without isolating them with open areas by prolonging the persistence of snowshoe hare habitat and retaining coarse woody debris for denning sites. The 2006 Lynx Plan also describes how WADNR will monitor and evaluate the implementation and effectiveness of the plan. The WADNR has been managing for lynx for almost two decades, and the Service has concluded that the management strategies implemented are effective. In the final revised critical habitat designation, published in the Federal Register on February 25, 2009 (74 FR 8657–8658), we determined that the benefits of excluding lands managed in accordance with the WADNR 2006 Lynx Plan outweighed the benefits of including them in the designation, and that doing so would not result in extinction of the species. We, therefore, again are considering excluding 164.2 mi^2 of lands managed in accordance with the WADNR 2006 Lynx Plan from the revised lynx critical habitat designation.

Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within the north Cascades (Koehler *et al.* 2008, p. 1523), which has significantly affected the status of and current viability of the lynx population within this geographic unit. As discussed below under *Potential Threats/Stressors/Factors Influencing Viability*, there is significant risk of potential future wildfires to further affect the viability of lynx in this geographic unit. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943), and as discussed below, climate change may similarly affect the future viability of lynx within this geographic unit.

4.2.5 Unit 5 - Greater Yellowstone Area

Unit Description: This geographic unit includes the parts of southwestern Montana and northwestern Wyoming the Service designated as critical habitat (Unit 5) for lynx in 2014 (79 FR 54825-54826). It encompasses approximately 23,691 km^2 (9,147 mi^2) in portions of Carbon, Gallatin, Park, Stillwater, and Sweetgrass Counties in Montana; and Fremont, Lincoln, Park, Sublette, and Teton Counties in Wyoming, with ownership that is 97.5 percent federal (USFS, NPS, and BLM); 2.2 percent private; and 0.3 percent State. This unit includes parts of Grand Teton and Yellowstone national parks and the Bridger-Teton, Custer-Gallatin, and Shoshone national forests, and lands managed by the BLM's Kemmerer and Pinedale Districts. It includes parts of the Absaroka, Beartooth, Gallatin, Gros Ventre, Salt River, Teton, Wind River, and Wyoming mountain ranges. This unit is not directly connected to lynx habitats and populations in Canada or to other DPS populations, although lynx dispersing from the north likely arrived intermittently into the area historically and, more recently, some lynx released into Colorado traveled into and through this unit (see Devineau *et al.* 2010, p. 526). Relative to other DPS lynx populations, this unit is about 145 km (90 mi) southeast of the Northwestern Montana/Northeastern Idaho unit, and roughly 400 km (250 mi) northwest of the Western Colorado geographic unit.

Habitat Description: In northwestern Wyoming and the GYA, lynx are generally associated with Englemann spruce-subalpine fir and lodgepole pine of the Rocky Mountain Conifer Forest vegetation class, as described above (Section 4.1.3) for the northwestern Montana, although this habitat and, thus, lynx typically occur at higher elevations (2,000-3,000 m [6,550-9,850 ft]) in the GYA (McKelvey *et al.* 2000a, p. 245; ILBT 2013, p. 60). Potential lynx habitat in much of the GYA is naturally marginal (patchier and composed in many places of drier forest types), with fewer shrubs and a more open understory, and generally low to marginal hare densities, resulting in a spatially-limited distribution of lynx with large home ranges (Squires *et al.* 2003, pp. 5, 12-13; 68 FR 40090; 71 FR 66010, 66029; 74 FR 8624, 8643–8644; Hodges *et al.* 2009, entire; Berg and Gese 2010, p. 1750; 79 FR 54796; Lynx SSA Team 2016, p. 45). Among the three national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 42 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123).

In Yellowstone National Park, 7,732 km^2 (2,985 mi^2; about 86 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 2,784 km^2 (1,075 mi^2; 31 percent of the park, 36 percent of lynx forest types) is estimated to be potential lynx habitat (68 FR 40086). However, hares were completely absent from more than 36 percent of surveyed stands in Yellowstone National Park, and 96 percent had estimated hare densities below the 0.5 hare/ha threshold thought necessary to support resident lynx (Hodges *et al.* 2009, 870, 873-877). In contrast, estimated hare densities were >= 0.48 hares/ha in all surveyed stands on the Bridger-Teton National Forest in the southern portion of the GYA, with highest densities (1.7 hares/ha) in 30-70-year-old regenerating lodgepole pine stands with dense horizontal cover, and densities of 1.2 - 1.6 hares/ha in mature multi-storied spruce-fir and mixed spruce-fir (containing aspen or lodgepole pine) stands (Berg *et al.* 2012, p. 1483). In the central Wyoming Range in the southern part of this unit, hare tracks were more abundant in seral aspen stands with a

significant spruce-subalpine fir component than in aspen stands with little or no spruce-fir, and hares appeared to be absent from pure aspen stands except where they bordered spruce/fir areas (Endeavor Wildlife Research 2009, p. 4). The only lynx den sites described for this unit (the natal den and a subsequent maternal den of one female in 1998) occurred in a mature subalpine fir-lodgepole pine forest in the Wyoming Range, where coarse woody debris and high sapling density provided dense horizontal cover (Squires and Laurion 2000, pp. 346-347).

Average annual snowfall in this unit ranges from about 127 cm (50 in) in Bozeman and 556 cm (219 in) in West Yellowstone, Montana, on the northern and northwestern peripheries of the unit, respectively, to 280-310 cm (110-122 in) in Alpine, Dubois, and Jackson, WY near the central and southern peripheries, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 8/17/2016). In potential lynx habitats on the Bridger-Teton National Forest in the southern half of this unit, deep snow persisted from late October through May (Berg *et al.* 2012, p. 1481).

Habitat Status: Potential lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 97 percent (23,109 km^2 [8,922 mi^2]) of this unit is in federal ownership, including 18,877 km^2 (7,292 mi^2) in national forests under USFS management, 3,944 km^2 (1,523 mi^2) in national parks managed by NPS, and 271 km^2 (105 mi^2) managed by BLM. As described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2008 and 2010 revised its RMPs for the Pinedale and Kemmerer districts, respectively, to include conservation measures and BMPs for lynx based on the LCAS (BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). On lands with developmental land-use allocations, these amended forest plans and the revised BLM RMPs provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has l kely benefitted lynx by providing a consistently-applied framework for conserving and restoring important hare and lynx habitats.

As elsewhere in the DPS (Squires *et al*. 2010, p. 1656; ILBT 2013, pp. 20, 27), winter foraging habitat is likely the most limiting habitat for lynx in this unit, and denning habitat is not thought to be limiting. Standards, guidelines and BMPs in the NRLMD and in revised BLM plans restrict vegetation management activities that could reduce winter snowshoe hare habitat and direct the creation or retention of coarse woody debris in areas where denning habitat may be lacking (USFS 2007, Attachment 1, pp. 2-5; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America,

showing that most of this geographic unit has a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

This unit includes substantial areas in nondevelopmental land-use allocations, including (in addition to Yellowstone and Grand Teton national parks) the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie designated wilderness areas. Among the three national forests that contribute to this unit, 75 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34). Management activities in these areas are unlikely to adversely impact lynx and hare habitats.

Large parts of Yellowstone National Park burned in the extensive wildfires of 1988. Although the extent to which those fires may have impacted potential lynx habitats is uncertain, some of the burned areas may soon reach a stage of regeneration capable of supporting increased densities of hares, perhaps increasing the likelihood that lynx could reestablish and maintain home ranges in some parts of the park (Lynx SSA Team 2016, p. 45).

Because non-federal lands make up less than 3 percent of lynx habitats in this unit, it is unlikely that activities on those lands have impacted lynx populations or meaningfully influenced the unit's current capacity to support resident lynx.

Overall, although naturally fragmented and patchily-distributed, potential lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway, railroad) development, past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

In summary, much of this geographic unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental land-use allocations, where management activities with the potential to adversely affect lynx habitat generally do not occur. Almost all lands with developmental land-use allocations in this unit are managed by the USFS to conserve and maintain lynx and hare habitats under management plans that were formally revised in 2007 in accordance with the NRLMD and based on the scientific findings and conservation recommendations of the LCAS. A small proportion of lands with developmental allocations occurs on BLM lands where management plans also were revised recently (2008 and 2010) to adopt conservation measures identified in the LCAS. Implementation of these USFS and BLM plans likely precludes landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places. Additionally, because lynx habitats in this unit are naturally highly-fragmented and, in most places, support low landscape-level hare densities, relatively minor impacts, especially to hare and lynx winter foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit. As described in section 2.3.2.2 above, the historic record and recent research show that the GYA has supported resident lynx, but it is unclear whether the area consistently supported a persistent resident population over time or whether it naturally supported resident lynx only intermittently. Most historic and recent verified lynx records are from the southern portion of this unit in the Gros Ventre, Salt River, Wind River, and Wyoming mountain ranges in the Bridger-Teton National Forest. Eighteen lynx were reported to have been trapped from a small area in the Wyoming Range in 1971-72 (Squires and Laurion 2000, p. 338), but it is unknown whether any of those lynx were residents (and if so, how many) or if some or all of them were dispersers associated with the "explosion" (irruption) of lynx documented in several places in the contiguous U.S. in the early 1970s (McKelvey *et al.* 2000, pp. 235-242). However, two resident lynx, a male and a female, were trapped, radio-marked, and monitored in the Wyoming Range over several years beginning in 1996. The female produced four kittens in 1998 and two in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000 (Squires and Laurion 2000, p. 346; Squires *et al.* 2001, pp. 9, 26). The female's home range averaged 50 km^2 (19 mi^2) over the 3 years she was monitored, and the male's averaged 824 km^2 (318 mi^2) over five years (Squires *et al.* 2003, pp. 12-13). The male also made multiple long-distance exploratory movements (up to 728 km [452 mi], including multiple highway crossings) over 3 successive years (Squires *et al.* 2003, pp. 13-16; Squires and Oakleaf 2005, entire).

Other surveys also detected lynx in the southern portion of this unit from 1999-2009, with records most consistent in the Wyoming Range, Togwotee Pass, Union Pass, the Bondurant Corridor, and in the Gros Ventre Range (Squires *et al.* 2001, pp. 9-14; Squires *et al.* 2003, pp. 9-11, 29-31; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Squires *in* Lynx SSA Team 2016, pp. 20-21). Additionally, 10 radio-marked lynx released in Colorado subsequently moved into or through this portion of the GYA unit from 2004-2010, with locations concentrated in areas used previously by native Wyoming lynx (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.). Several of the Colorado-released lynx occupied home ranges (including overlapping male and female home ranges) in areas of the Wyoming Range previously occupied by "native" resident lynx (Squires *in* Lynx SSA Team 2016, p. 21), but there is no evidence of reproduction among these lynx. On the Shoshone National Forest in the northeastern part of this unit, seven lynx snow tracks were confirmed by DNA analysis in winter 2005/06, and a single track was verified the following winter (Endeavor Wildlife Research 2008, p. 2; Berg 2016, pers. comm.). During the winters of 2004-05 through 2007-08, 26 snow tracks on the Bridger-Teton and Shoshone national forests were confirmed by DNA analyses to be from five individual lynx (3 males, 2 females). One of the males had previously been documented in Yellowstone National Park (see below). The other two males and both females were lynx that had been released in Colorado (Pilgrim 2016, pers. comm.).

Verified records of lynx are less common elsewhere in this unit, including in Yellowstone and Grand Teton national parks and the Custer-Gallatin National Forest. There were no verified records of lynx in Yellowstone National Park from 1920-1999 (McKelvey *et al.* 2000, p. 230); however, surveys in 2001-2004 documented at least 3 individual lynx, including two kittens, in

the eastern part of the park (Murphy *et al.* 2006, entire). Several Colorado-released lynx also traveled through the park (Devineau *et al.* 2010, p. 526), and two possible (unconfirmed) lynx tracks were recorded in the park during winter 2008/2009 (Endeavor Wildlife Research 2009, pp. 4, 12). On the Custer-Gallatin National Forest in Montana in the northern part of the unit, a single female was detected over six consecutive winters (2003/2004 - 2008/2009) but not subsequently (Gehman *et al.* 2010, pp. 2-4), and it appears that she did not encounter a male or produce kittens during the six years she was detected (Gehman *et al.* 2010, p. 4).

Recent surveys and research-related trapping efforts have failed to detect lynx in this unit after 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45; Hanvey 2016, pers. comm.). As discussed above and in section 2.3.2.2, it is uncertain whether this unit historically supported a small but persistent resident population that was recently extirpated, or if it historically and recently has supported resident lynx only intermittently. Given the protected conservation status of millions of acres in this unit, its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx (Lynx SSA Team 2016, p. 57). Conversely, the characteristics described above suggest that relatively small impacts could tip this unit from just barely able to support a persistent resident population to incapable of doing so. Further, the available evidence suggests that if this unit did support a persistent population, it was very likely a very small one, which would be more vulnerable to extirpation due to demographic, environmental, and genetic stochasticity, and to catastrophic events (McKelvey *et al.* 2000b, pp. 23-29), or to a combination of these factors.

Factors Affecting Current Conditions: *Regulatory Mechanisms* - As described above for Unit 3, federal management activities (e.g., timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level to threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distr bution of lynx habitats in some parts of this unit. Current regulatory mechanisms and conservation measures associated with recently amended or revised federal management plans are intended to conserve and restore lynx and hare habitats across large landscapes. Although their effectiveness has not been quantitatively evaluated, they have almost certainly reduced significantly the potential for adverse management-related impacts to lynx habitats in this unit.

Lynx trapping has been prohibited in Wyoming since 1973 (79 FR 54794) and in Montana since 1999 (MTFWP 2016, p. 7) and, as described in section 3.1.2, above, both states require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, no lynx are documented to have been incidentally trapped in the Montana portion of this unit (MTFWP 2016, pp. 5-10) and we are aware of no incidental captures in northwestern Wyoming since listing.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Mote *et al.* 2005, entire; Pederson *et al.* 2013; Riley *et al.* 2013; Dennison *et al.* 2014, entire; USEPA 2015, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities low in some places, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609).

Vegetation Management - The influence of vegetation management on the current condition of lynx and habitats in this unit is described above under Habitat Status and *Regulatory Mechanisms*.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, likely in response to climate warming and related increases in drought conditions (e.g., Dennison *et al.* 2014, entire; Harvey *et al.* 2016, entire; Westerling 2016, entire), with most large, stand-replacing fires having occurred in the northern part of the unit, in Yellowstone National Park (see Harvey *et al.* 2016, Fig. 1). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to continue to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction on lands with

developmental allocations. Much of this unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental allocations. Even in areas with developmental allocations, the moist subalpine forests important to lynx have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx. Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Wyoming (1; a Colorado-released lynx) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates of are unknown. Although this unit is not directly connected to lynx habitats and populations in Canada or elsewhere in the contiguous U.S., no barriers to lynx dispersal from the north have been identified, and 10 lynx released in Colorado are known to have dispersed northward into and through this unit (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.), demonstrating that dispersal between the southern and northern Rockies is poss ble. As described above in Lynx Status, the large number of lynx reportedly trapped from a small area of the Wyoming Range in the early 1970s (Squires and Laurion 2000, p. 338) may suggest dispersers associated with the irruption of many lynx from Canada into the northern contiguous U.S. documented at that time (McKelvey *et al.* 2000, pp. 235-242). No subsequent pulses of lynx dispersing from the north have been documented, and lynx trapping records suggest that the magnitude of lynx populations cycles in Alberta and British Columbia, the most likely source of lynx dispersing southward into this unit, dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

As described in section 3.2, above, a number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this geographic unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, it is possible that it has contributed to the recent apparent loss of resident lynx from this unit.

4.2.6 Unit 6 - Southern Rockies Geographic Area

Unit Description - The overall geographic unit includes Colorado, south-central Wyoming, and north-central New Mexico. However, within the southern Rockies, since we currently have no evidence of resident lynx in southern Wyoming or northern New Mexico, and we question the ability of these two areas to support breeding populations we are not including these two areas in the unit description. Lynx habitat in Colorado totals approximately 25,294 km^2 (9,766 mi^2), and is distributed west of US Interstate-25. We excluded the northwest part of the state bounded on the south by US Interstate-70 and the east by Colorado State Highway 13, because this area lacks sufficient habitat to support lynx. Lynx habitat in Colorado falls within the following land ownerships, USFS 21,555 km^2 (8,322 mi^2), BLM 772 km^2, (298 mi^2), NPS 452 km^2 (174 mi^2), Private 2,350 km^2 (907 mi^2), State 164 km^2 (63 mi^2).

The southern Rockies are separated from the rest of the Rocky Mountain chain, and thus lynx habitat in northern and western Wyoming, by sagebrush and desert shrub communities in the Wyoming Basin and the Red Desert of southern and central Wyoming, and the arid Green and Colorado River plateaus of western Colorado and eastern Utah. Connectivity of lynx habitat has been identified as an important consideration for the southern Rockies, because of the extreme topographic relief juxtaposed with human developments such as highways and residential communities.

Habitat Description - Lynx habitat in the southern Rockies is found within the subalpine and upper montane forest zones, generally above 2,900 m (9,514 ft) elevation (Shenk 2009 page 10). In the upper elevations of the subalpine zone, forests are typically dominated by subalpine fir and Engelmann spruce. As the subalpine zone transitions to the upper montane, spruce-fir forests begin to give way to lodgepole pine and aspen. On cooler, mesic mid-elevation sites, Engelmann spruce may retain dominance, intermixed with aspen, lodgepole pine, and Douglas-fir. Lodgepole pine reaches its southern limits in the central part of the geographic unit, while southwestern white fir occurs only in the San Juan Mountains. The lower montane zone is dominated by ponderosa pine and Douglas-fir, with pines typically dominating on lower, drier, more exposed sites, and Douglas-fir occurring on the more sheltered sites. Lower montane forests do not support snowshoe hares and seldom would be used by lynx.

Mature Engelmann spruce/subalpine fir forests with total canopy cover of 42–65 percent, of which 15–20 percent was contr buted by conifer understory tree canopies, were the most commonly used areas, followed by mixed forests of Engelmann spruce/subalpine fir/aspen (Shenk 2008, page 15). Riparian and riparian-mix was the third most-used cover type, with a pattern of increasing use beginning in July, peaking in November, and dropping off in December. Large or medium willow/alder carrs and willow riparian communities provided important habitat for snowshoe hare, grouse, ptarmigan (winter), and other prey species that could be utilized by lynx.

Ivan *et al.* (2012 page 5) confirmed some relationships that were already known (e.g., lynx are strongly associated with high-elevation spruce/fir and mixed spruce/fir forests but avoid lower-

elevation montane forests and montane shrublands). We recognize that all spruce-fir forest does not support lynx equally based on the low detection rate (28 percent) reported during the ongoing lynx study in the San Juan Mountains within predominantly spruce-fir forest (Ivan, Workshop presentation 2015, p. 14), thus not all areas of spruce-fir forest are used by lynx.

Dolbeer and Clark (1975 page 539) estimated a density of 0.73 hares/ha (0.3 hares/ac) within their study site in Colorado, with the highest densities of snowshoe hare in mature and late-successional spruce-fir forests. However, this study was conducted in a very limited area and did not sample younger sapling-stage stands (15-40 years post-disturbance) to compare hare densities with those reported for mature and late-successional spruce-fir forests (USFWS 2008, p. 32).

Habitat that supports snowshoe hares is patchily distr buted in the Southern Rocky Mountains Geographic Unit, which limits their abundance. Zahratka and Shenk (2008 entire) found densities of snowshoe hares to be greatest in mature Engelmann spruce-subalpine fir stands when compared to mature lodgepole pine stands in Taylor Park, Colorado. Their density estimates were 0.08±0.03 to 1.32±0.15 hares/ha (0.03–0.5 hares/ac) in Engelmann spruce-subalpine fir habitats, and 0.06±0.01 to 0.34±0.06 hares/ha (0.02–0.14 hares/ac) in lodgepole pine habitats (Zahratka and Shenk 2008 entire).

Ivan (2011*a in ILBT 2013*) compared snowshoe hare density, survival, and recruitment in mature uneven-aged spruce/fir stands, small-diameter lodgepole pine (2.54–12.7 cm [1–5 in]) stands (20–25 years old), and medium-diameter (12.7–22.9 cm [5–9 in]) previously-thinned lodgepole pine stands (40–60 years old) in Colorado. During summer, Ivan (2011*a* in *ILBT 2013*) recorded densities of 0.2+0.01 to 0.66+0.07 hares/ha (0.08–0.27 hares/ac) in small lodgepole pine forest, 0.01+0.04 to 0.03+0.03 hares/ha (0.004–0.01 hares/ac) in medium lodgepole forest, and 0.01±0.002 to 0.26±0.08 hares/ha (0.004–0.1 hares/ac) in spruce/fir forest; densities were more similar across the 3 forest types during the winter months. He concluded that “hares reached their highest densities and recruited juveniles most consistently in stands of small lodgepole, followed closely by spruce/fir, but survival was highest in spruce/fir stands.”

Habitat Status - At the time of the 2000 listing, we identified 26,305 km^2 (10,156 mi^2) of potential lynx habitat in the Southern Rockies (i.e., Colorado and southern Wyoming) [65 FR 16052). In 2003, we estimated 31,027 km^2 (12,419 mi^2) of potential habitat within the southern Rockies (68 FR 40076). As stated above, our focus here is limited to the state of Colorado. In 2008, the USFS reported that most of their LAUs in the southern Rockies fell within a range of 3-8 percent in a currently unsuitable condition, with only one LAU exceeding 30 percent unsuitable (USFS 2008, p. 19). Currently, the USFS reports 51 out of 202 (25%) LAUs currently exceed the 30 percent unsuitable condition (P. McDonald 2016, pers. comm.). These changes are mostly in response to the ongoing bark beetle infestations, as well as wildfire events that have occurred since 2008.

Ivan *et al.* (2012, p. 6), developed a predictive map of lynx habitat use by using lynx location data collected during CPWs reintroduction monitoring, then estimated the amount of habitat associated with a high probability of detecting lynx. Our review of the vegetative characteristics of CPW's predictive map detected large areas of spruce-fir habitats that were excluded by their presentation of the habitat associated the top 20 percent of predicted use. Therefore, we selected the top 30 percent of the Ivan *et al.* (2012, entire) predictions and the associated habitat to represent the amount of potential lynx habitat in Colorado totaling 25,294 km^2 (9,766 mi^2). This habitat estimate falls between the Ivan *et al.* (2012, p. 6) estimate and the USFS's habitat estimate of 30,664 km^2 [11,839 mi^2] (USFS 2008, p. 18), while retaining a greater than 60 percent probability of detecting lynx as described by Ivan *et al.* (2012).

Regulatory mechanisms in Colorado are largely provided through Forest Service planning documents. All USFS land management plans within the unit were amended in 2008 to provide for the conservation of lynx. Three BLM plans in Colorado have been amended or revised to conserve lynx following the 2013 LCAS, totaling approximately 126 km^2 (49 mi^2). One additional plan provides conservation measures for timber management actions only, but the FO contains only about 1 km^2 (0.39 mi^2). The remaining FOs currently have not amended or revised their plans specifically to provide conservation for lynx (approximately 645 km^2 (298 mi^2), Since the 2000 listing however, all BLM Field Offices in Colorado have been conserving lynx discretionarily through application of conservation measures provided in the Lynx Conservation Assessment and Strategy (Ruediger *et al.* 2000, entire; ILBT 2013, entire). Rocky Mountain National Park has a fire management plan that includes conservation measures for lynx. We are not aware of any specific conservation planning guiding activities on non-federal lands (M. Wrigley 2016, pers. comm. ; M.K. Watry 2016, pers. comm.).

Lynx Status - As of 2016, the current distribution of lynx is somewhat uncertain within Colorado. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell 2016, undocumented pers. comm.), and Rocky Mountain National Park (Shenk 2008, p. 3). The CPW is developing a minimally-invasive, long-term, statewide monitoring program to track the distribution, stability, and persistence of lynx in Colorado (Ivan 2012, entire).

As of 2015, evidence of recent lynx reproduction is provided through kittens captured on game cameras accompanying adult females at three locations during 2014-2015 monitoring effort (Ivan presentation 2015 page 17). In addition 38 percent of lynx captured during recent (2010-2015) USFS Rocky Mountain Research Station research projects in Colorado have been young and/or unmarked cats (Ivan *in* Lynx SSA Team 2016, p. 17), suggesting continued reproduction within Colorado. However, reproductive rates are currently unknown.

As of 2007, the average probability of survival for reintroduced lynx was 0.9315±0.0325 within the study area in the San Juan Mountains and 0.8219±0.0744 outside the study area boundary (Devineau *et al.* 2010, page 5). Although 30 percent of known mortalities were due to human causes (being shot or hit by a vehicle), the estimate of survival within the study area was higher than those reported for natural, lightly trapped populations of Canada lynx in the Yukon (0.75–

0.90; Slough and Mowat 1996 entire, O'Donoghue *et al.* 1997, page 155) or in the Northwest Territories (~0.90; Poole 1994, page 612). Successful reproduction, including by females born in Colorado, has been documented (Shenk 2008, page 2), and kitten survival was 0.2260 (Jake Ivan, pers comm. March 9, 2016).

Factors Affecting Current Conditions - Colorado is currently experiencing major bark beetle epidemics in lodgepole pine and spruce-fir forests. Although bark beetles are native insects, and forests in the western U.S. have experienced regular insect infestations throughout their history, the current bark beetle epidemic is notable for its intensity and extensive geographic range. The causes of this epidemic include: relatively even-aged, dense, and homogenous forest conditions, which are highly susceptible to beetle attack, and which were created by large-scale logging in the late 1800s and subsequent fire suppression efforts; warmer winters due to climate change (cold winters typically reduce beetle populations); and a multi-year drought that occurred in the mid-1990s through early 2000s, stressing the trees and making them more susceptible to beetle attack (USFS 2011, pp. 4).

In lodgepole pine forests, a mountain pine beetle (*Dendroctonus ponderosae*) epidemic typically kills the entire overstory and results in a stand-replacing disturbance event. In Colorado, more than 1,375,931 ha (3,400,000 ac) has been affected by mountain pine beetle, and 639,000 ha (1,579,000 acres) affected by spruce beetle since 1996 (USFS 2015, p. 3), a portion of which overlaps with lynx habitat.

Even-aged mature and "dry" lodgepole pine stands characteristically have depauperate understory vegetation and are not capable of supporting dense populations of snowshoe hares. On moist sites, regeneration of beetle-killed lodgepole pine stands is expected to be relatively rapid 20-30 years, and the new stands will be dominated by resprouting aspen or by a new cohort of lodgepole pine. If these newly-established stands grow tall and dense enough to provide horizontal cover above the snow layer, they may produce excellent habitat for snowshoe hares and lynx for several decades, until the crowns again lift above the reach of snowshoe hares.

A spruce beetle epidemic kills the larger-diameter trees and can also result in a stand-replacing disturbance event. Because of the importance of spruce-fir forests for production and survival of snowshoe hares (Ivan 2011a in ILBT 2013), widespread mortality of mature spruce/fir forests could impact lynx habitat for a long duration. By 2015, the spruce beetle outbreak influenced approximately 95 percent of the mature spruce component of the subalpine cover types on the Rio Grande National Forest (Squires *et al.* unpublished report 2016, page 1). Despite the large scale, and almost complete mortality of the mature spruce component within their study area, lynx continue to use and reproduce in the beetle-infested forests (Squires *et al.* unpublished report 2016, page 2). Since the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. However, habitat connectivity may be negatively affected by intense recreational use or development within strategic areas that are important for habitat connectivity.

ILBT (2013 p. 57; 61-62) states:

> *Plague, a flea-borne disease caused by the bacterium Yersinia pestis, which is not native to North America, was reported for the first time in lynx in Colorado (Wild et al. 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 reintroduced lynx between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to Y. pestis; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado.*
>
> *Vehicular collisions are a potentially important cause of mortality for lynx in portions of the southern Rockies. Thirteen of 102 mortalities documented for lynx translocated into Colorado were from vehicle collisions (Devineau et al. 2010). Brocke et al. (1990) suggested that translocated animals might be more vulnerable to highway mortality than resident lynx and this could have been a factor in Colorado at the time of listing. Currently, the majority of lynx mortalities caused by vehicle collision (13 of 16) occurred during the reintroduction period (1999-2006). Since early 2007, one year after the final reintroductions occurred, only 3 hit by vehicle mortalities have been reported, and only two of those occurred in Colorado (Broderdorp unpublished data 2016). A number of highways with high speed and high traffic volume pass through lynx habitat, such as I-70, I-80, US 50, US 550 and US 160. These highways are not a barrier to lynx movement, as repeated successful crossings by radio-telemetered lynx have been documented on I-70 and Highways 9, 40, 50, 91, and 114 (Ivan 2011b, c, 2012; J. Squires, personal communication 2012). At this time, it appears that hit by vehicle mortality may be a less significant mortality factor for lynx in Colorado.*
>
> *As compared with other portions of the range of lynx, in Colorado more winter recreation and associated development overlaps with lynx habitat. Preliminary information from a study in Colorado indicates that some winter recreation uses may be compatible, but lynx may avoid some developed ski areas (J. Squires, personal communication 2012). It is possible that ski areas and 4-season resorts may reduce the amount and availability of lynx habitat within localized areas, in part by influencing the distribution or abundance of prey resources within the developed area. However, there is also considerable anecdotal evidence of lynx using ski areas.*
>
> *Leg-hold trapping is currently prohibited under the state constitution of Colorado as a means of predator control or for commercial and recreational trapping. If a landowner can prove that all other non-lethal methods have been ineffective, a 30-day exemption may be granted for depredation cases. Incidental trapping mortality of lynx may be a minor risk during trapping seasons in southern Wyoming and surrounding states.*
>
> *Predator control activities on federal lands, including coyote shooting or trapping, are common throughout most of this geographic area, mostly related to the grazing of domestic sheep. The majority of sheep grazing occurs on arid rangelands, but some*

grazing does occur during summer at the higher elevations, especially in south-central Colorado. Incidental capture of lynx is possible, but unlikely.

Chapter 5: Future Conditions

In this chapter, we present our assessment, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the potential future status of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the likely future conditions in each geographic unit, followed by a more detailed evaluation of the factors likely to influence lynx populations and habitats in each unit. We present and summarize the professional judgments and opinions of a panel of 10 lynx experts regarding the factors likely to influence the persistence of resident lynx populations in the DPS as a whole and in each of the six geographic units. We also present and summarize the experts' projections, based on consideration of those influencing factors, of the probability that each of the geographic units will continue to support resident breeding populations of lynx into the future (at years 2025, 2050, and 2100). We then provide additional Service review of the influencing factors described in Chapter 3, above, and their potential effects on the ability of each geographic unit to support lynx populations in the future.

5.1 Summary of Future Conditions DPS-wide

Given the irresolvable uncertainty about the historical distribution of resident lynx in the contiguous U.S. and the current lack of reliable estimates of the sizes, trends, and many demographic parameters for most DPS populations, it is difficult to confidently predict the future status of the DPS or the likelihood that any given geographic unit will support resident lynx in the future. We lack data to build rigorous empirical population models for lynx in the DPS, and uncertainty regarding the timing and magnitude of potential impacts to lynx from continued climate warming also limit our ability to predict future conditions for the DPS. Therefore, our assessment of the future of the DPS is based on the best professional judgments an opinions of lynx experts and our evaluation of the available scientific information regarding the factors identified by the ILBT as the most likely to have population-level impact to lynx in the DPS (ILBT 2013, pp. 68-78).

Overall, expert opinion and our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). This outcome seems likely regardless of which climate emissions scenario is used to model future conditions, although the timing, extent, and magnitude of impacts is uncertain and will likely vary by scenario.

In addition to climate change, forest management also has the potential to influence (negatively or positively) hare and lynx habitats in the DPS range. Forest management on private lands that lack lynx conservation commitments may contribute to future declines in the amount and quality of lynx habitats, particularly in Maine and perhaps also in Minnesota (private lands contribute minimally to lynx habitats in the other geographic units – see Table 1, above). Uncertain future forest ownership and markets for forest products, shifts in silvicultural practices, and development pressures on private lands all may affect the resiliency of future lynx populations and thus the units. The lack of evaluation of the effectiveness of forest management plans for lynx on federal lands is of concern for western units.

In each geographic unit, the probability that resident lynx populations will persist is expected to decline in the future, although uncertainty about persistence probability increases with time from the present (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below). Although all five geographic units that currently support resident populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century. All other geographic units have a 50 percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below), with a moderate to high likelihood that resident lynx will be lost from two to four units by then (Figure 7).

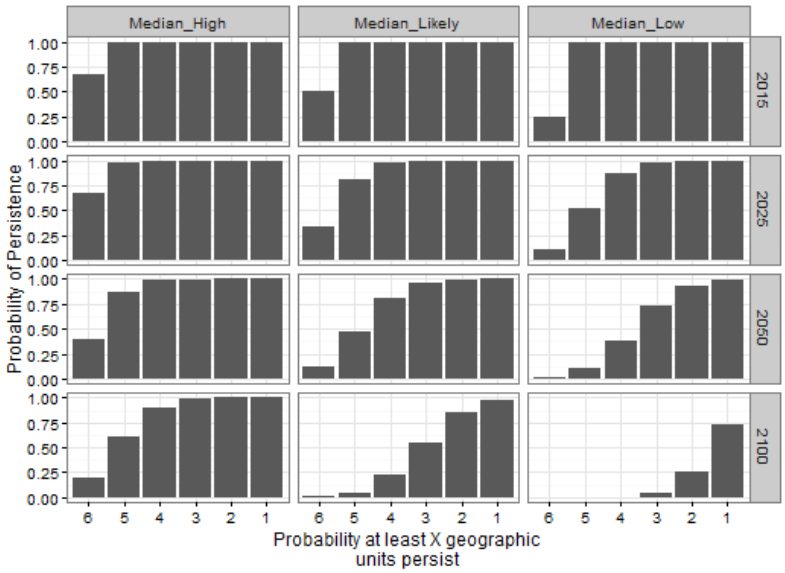


Figure 7. Summarized probability of persistence of at least a given number of geographic units given the probability of persistence for each individual geographic unit. The y axis of each grid in

Figure 7 is the probability that at least the number of geographic units indicated by the x axis of the grid persist. The probability in a bar reaches 1 when there is no probability of fewer geographic units persisting. Moving from top to bottom the grids show the probabilities by time period (2015, 2025, 2050, and 2100). Moving from left to right the grids show the range of expert responses by summary selection type and probability response. Therefore looking down a column of grids provides a view of the trend in persistence through time and looking across a row of grids provides a view of the range of uncertainty in persistence for a given time period.

The loss of resident lynx from one or more geographic units would represent reduced future redundancy, representation, and resiliency within the lynx DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (e.g., additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and l kely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Based on expert input, there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and l kely future relative genetic health of the DPS.

How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

In terms of resiliency, expert opinion and our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are l kely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are l kely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

5.1.1 Summaries of Future Conditions in Each Geographic l Unit

Unit 1 – Northern Maine: Although the Northern Maine geographic unit currently has extensive lynx habitat, it may be one of the units in the DPS at greater risk. Forestry practices and climate change will be the greatest future drivers of hare and lynx habitat. Lynx habitat and numbers are expected to decline by 50 to 60 percent by 2032 in response to aging of the budworm-era clearcuts and the effects of 27 years of extensive partial harvesting. In the next few decades, high quality hare habitat will drop from about 10 percent to 5 percent of the landscape. High quality habitat patches will become more fragmented, smaller, and more isolated, thus making the landscape less suitable for lynx. For the next few decades the best habitat will occur in the southern portion of the range where effects of climate change and competition with bobcats are l kely to be greatest. Absent long-term lynx management agreements, the future of lynx habitat is uncertain. Wood products markets will continue to change, and could be affected by interest in carbon sequestration in response to climate change. Rapid changes in private forest land ownership are likely to continue resulting in subdivision of large ownerships. Changing land uses (wind energy development, transmission line corridors, residential and development, national monument) will compete with forest management as the primary land use. Conservation easements will help reduce development pressures and keep some lands as working forest. Climate change is expected to affect the Maine unit more than others in the DPS because snow depth and duration already seem to be at thresholds for lynx and there are few potential elevational refugia. In the near term and to mid-century, snow quantity and quality will continue to deteriorate, likely causing the range of lynx to begin contracting northward. In the long term (to 2100), some believe lynx could become extirpated from the unit. Climate change, increasing demand for hardwood forest products, a pending spruce-budworm outbreak, and frequent disturbance of the forest all will contribute toward the trend in the loss of spruce-fir forest and expansion of northern hardwoods, although the timeframe for conversion is uncertain. Lynx experts indicate the probability of persistence will decline to about 50% by the end of the century. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, lack of elevational refugia), some members of the Service's SSA

team were more pessimistic about the future of lynx in Maine than the lynx expert panel. There is great uncertainty about the future of forest management and future development on private forest lands. There are no long-term management plans in place, State forest regulations have greatly influenced harvesting practices that have (and will continue to) reduce landscape hare densities, markets for forest products are depressed, and projections (under current harvest scenarios) are that habitat will diminish and shift southward in the near term because of post-harvest succession and recede northward over the longer-term because of continued climate warming.

Unit 2 - Northeastern Minnesota: The direct and indirect effects of climate change are expected to affect lynx into the future in Minnesota. Specifically, there is an expected decline in the quantity, quality, and duration of snow; increased competition and hybridization with bobcats; northward contraction of boreal conifer forest; and increased isolation due to diminishing forest conditions in Ontario. The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century, driven in the near term by the quality, quantity and persistence of snow, competition, disease, and forest insects, and over the long term from the some of the same reasons with the addition of climate change, loss of spruce-fir forests, and wildfires. If the SNF in Minnesota continues to follow vegetation management and other recommendations under the LCAS in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue on State and private lands. Taking all factors into consideration (i.e., loss of boreal forest, increased competition, potential disease and insect outbreaks, loss of snow), lynx experts projected the mean probability persistence of lynx in Minnesota to the year 2025 was greater than 90 percent, to 2050 was 80 percent, and would decline to approximately 35 percent by 2100.

Unit 3 - Northwestern Montana/Northeastern Idaho: As in other units, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Fire- and insect-related habitat losses would likely be temporary, resulting subsequently in improved habitat conditions when impacted areas regenerate the dense vegetative structure conducive to hare abundance. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Lynx experts felt that future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Considering the factors above, lynx experts felt this geographic unit has the highest likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence >

0.95), at mid-century (median = 0.90), and end-of-century (median = 0.78), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units.

Unit 4 - North-central Washington: Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within north Cascades, which has significantly affected the status of and current viability of the lynx population within this geographic unit. Similar to the other geographic units, climate change is anticipated to reduce the future quality and distr bution of lynx habitat in Washington, potentially further exacerbating the recent temporary losses of lynx habitat from wildfires. Climate change may increase wildfire frequency and severity, which may result in further temporary losses of lynx habitat. Climate change may also decrease the quantity and quality of snow resulting in permanent reductions in the quantity and distr bution of lynx habitat in Washington State. These potential climate change driven reductions of lynx habitat may serve to further isolate lynx populations within Washington State as well as between neighboring lynx populations in the other geographic units and Canada. Continued forest management on both federal and State lands will benefit lynx populations in Washington, but this may not completely ameliorate the potential negative effects related to climate change. Considering the recent reduction in lynx habitat and the projected impacts of climate change, experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), mid-century persistence at 30% to 80% (median = 70%), and end-of century (year 2100) persistence probabilities less than 50% (median = 38%) for lynx populations within this geographic unit.

Unit 5 - Greater Yellowstone Area (GYA): As elsewhere, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Because potential habitats in much of this unit already are naturally highly fragmented and perhaps only marginally capable of supporting resident lynx, and because it appears to have never supported more than a small number of residents, its ability to do so in the future is tenuous. Lynx experts felt that the small number of lynx this unit appears capable of supporting and its relative isolation from other lynx populations make it more vulnerable to genetic drift and extirpation due to catastrophic events or demographic or environmental stochasticity. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Considering the factors above, lynx experts felt this geographic unit has the lowest l kelihood of supporting resident lynx into the future in the near term (year 2025; median probability of persistence = 0.52), at mid-century (median = 0.35), and end-of-century (median = 0.15), with a declining

probability of persistence and greater uncertainty with increasing time from present, as in all units.

Unit 6 - Western Colorado: Climate change is expected to affect vegetation and influence snow conditions within the Western Colorado unit. The elevation gradient in Colorado may provide refugia from deteriorating snow quality, depth, and duration throughout the period. Climate models suggest a 40 percent decline in snow persistence, but large areas of snow persistence will remain through the end of the century. Experts suggest that beetle kill and fire will result in unsuitable habitat conditions. However, these areas are likely to regenerate and provide excellent habitat conditions to support hares and lynx. A caveat to future habitat conditions in light of climate warming is that some areas that currently support snowshoe hare populations may experience vegetation type conversion that may not support snowshoe hares. The majority of the experts predicted the persistence of a viable lynx population in the unit by 2100, but further discussion revealed uncertainty about persistence in the unit, and genetic connectivity across ski areas in the unit.

Table 4, below, summarizes factors thought likely to influence the future resiliency of lynx populations in each geographic unit.

Table 4. Future (2050 to 2100) resiliency of individual units of the Canada lynx DPS

Lynx population	Lynx expert probability of persistence	Key evidence	Uncertainties
Unit 1 Maine	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	• 50% decline in habitat expected by 2032, habitat will occur in south edge of range • Slight recovery of habitat by end of century depending on forestry trends • Continued demographic and genetic connectivity to southern Quebec, New Brunswick populations • Climate models predict deteriora ing snow quality, depth and duration below thresholds for lynx; more severe than other units • Lit le elevation refugia	• Future forest management trends and habitat conditions on private forest lands in Maine and Canada • Future shifts in land ownership, forest products markets, and development • Extent and pace of deteriorating snow conditions • Response of hares (pelage mismatch), bobcat and fisher to changing snow regime • Extent and pace of loss of spruce-fir • Future trends in hare populations • Disease and parasites in lynx • Effects of lynx trapping in Quebec
Unit 2 Minnesota	2050 median 80% (range 35 to 100%) 2100 median 35% (range 0 to	• Smaller population could be susceptible to stochastic effects • Habitat conditions on na ional forests will remain stable or improve if managed for softwoods • Continued demographic and genetic	• Future forest management trends and habitat conditions on private forest lands in Minnesota and Ontario • Extent and pace of deteriorating snow conditions

	100%)	connectivity to southern Ontario populations ● Climate models predict deteriora ing snow quality, depth and dura ion below thresholds for lynx ● Lit le elevation gradient: lake-effect snow may retain refugia to 2050 but not 2100	● Response of bobcat and fisher to changing snow regime ● Rate of decline of spruce-fir ● Future trends in hare populations ● Disease and parasites in lynx
Unit 3 Northwestern Montana	2050 median 90% (range 40 to 100%) 2100 median ~78% (range 10 to 100%)	● Some habitat loss from increased wildfire, otherwise habitat will remain stable with USFS management ● Continued demographic and genetic connectivity to southern British Columbia popula ions ● Potential high elevation buffer against climate change ● Recent loss of small sub-metapopulation in Garnet Range ● Increasing fire frequency	● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future trends in hare populations
Unit 4 North-central Washington	2050 median 70% (range 10 to 100%) 2100 median ~38% (range 0 to 90%)	● Habitat and popula ion low because of recent fires; could be susceptible to stochastic effects ● Continued demographic and genetic connectivity to southern British Columbia popula ions ● Elevation is not sufficient to provide long-term refugia from deteriorating snow quality, depth, and duration	● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations
Unit 5 Greater Yellowstone	2050 median 35% (range 0 to 90%) 2100 median 15% (range 0 to 90%)	● Habitat loss from 1980s wildfire, otherwise habitat will remain stable with USFS and NPS management ● No connectivity with Canada populations; little immigration from DPS populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Low quality habitat; dry; low hare populations ● Smaller population could be susceptible to stochastic effects	● Will habitat support adequate landscape hare densities to support lynx? ● Extent to which GYA remains demographically isolated from other DPS populations; immigration from Colorado population ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations ● Extent to which high elevation may

			provide climate and snow refugia ● Extent to which area will be repopulated by the north and/or the south
Unit 6 Western Colorado	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	● Habitat loss from increased wildfire and insect outbreaks, otherwise habitat will remain stable with USFS management ● Isolation from other lynx populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Uncertainty about stability of recently-reintroduced lynx population	● Demographic and genetic effects of isolated population ● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of future insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future trends in hare populations

5.2 Future Conditions - Detailed Descriptions by Geographic Unit

5.2.1 Unit 1 - Northern Maine

Expert Projections of Future Lynx Status

Most experts indicated an initially high and subsequently declining probability of persistence of resident lynx in Maine through the end of the century, with uncertainty (range between lowest and highest probabilities) also increasing over time (Lynx SSA Team 2016, pp. 33-36 and Fig. XX below). Climate change was an overriding near- and long-term stressor.

Increased winter precipitation in the form of rain, reduced snow depth, and reduced snow durations were discussed. Changes in snow conditions will favor bobcats and fisher (a predator of lynx that is limited by deep snow). Experts believed that the effects of climate change would continue to increase as a stressor by mid- to the end of the century (2050, 2100). Snow conditions would continue to deteriorate (especially in the northern Maine unit compared to other areas in the DPS) resulting in increased competition with bobcats and predation by fisher. Climate-induced loss of spruce-fir forest will occur slowly, and an increase in northern hardwood composition of the forest is already occurring. Loss of spruce-fir could be accelerated by forest disturbance (budworm outbreak, forest management affecting large acreages of lynx habitat annually).

Experts expressed a number of near-term stressors (in the next 15 years) related to forest management in northern Maine. Land management objectives were uncertain because of changes in private forest land ownership. Changes in forestry management because of the Maine Forest Practices Act (shift to partial harvesting, increasing acreage harvest, habitat shifting to south) would result in increased fragmentation and declining lynx and snowshoe hare habitat (succession of previous clearcuts from young, dense regenerating stands to mature stands less conducive to high hare densities).

There was uncertainty concerning the severity and response by new landowners to the next spruce budworm outbreak. Experts were concerned that investment landowners would not respond to the pending spruce budworm outbreak like they did in the 1970s (extensive clearcuts, herbicide application). Experts also acknowledged concerns about the effects of the current clearcuts aging past conditions that support hares and lynx.

Hare populations have declined by about half across all stand types (and in adjacent Quebec) since 2006 and apparently have not rebounded. In response, lynx initially had lower reproduction (lower proportion of females breeding, slightly lower litter sizes), but this has not affected home range sizes. Lower landscape hare densities are likely to support lower lynx populations. It is uncertain how hare numbers will cycle or fluctuate in the future.

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of spruce-fir, and bobcat competition are likely to reduce the probability of lynx persistence in this unit. Modeling of current lynx habitat and future habitat trends was more advanced for the Northern Maine Unit than other units. Models indicate that aging of past clearcuts and changes in forest practices to partial harvesting will diminish the current lynx habitat by half in coming decades. Experts and the core team expressed uncertainty about the severity of a pending spruce budworm outbreak, forestry response by investment company landowners, and how this will affect future lynx habitat. More is known about long-term trends in snowshoe hare populations in this unit than others. Hares seem to have declined by half since about 2006 and have remained low. Experts and the core team were uncertain about whether hare numbers would rebound or remain at this lower level, but lower hare densities are affecting demographics (especially percentage of females breeding), which could contribute to population declines. Taking all of these factors into consideration, the experts projected the mean probability of persistence to the years 2025 was greater than 95 percent, to 2050 was about 80 percent (range from 20 to 100 percent), and to 2100 was about 50 percent (range from 0 to 100%)(Lynx SSA Team 2016, pp. 33-34, Fig. 8). The USFWS lynx core team generally agreed with this prognosis with the exception that some were less optimistic about the persistence of this population, especially after reviewing the literature pertaining to climate change in this region.

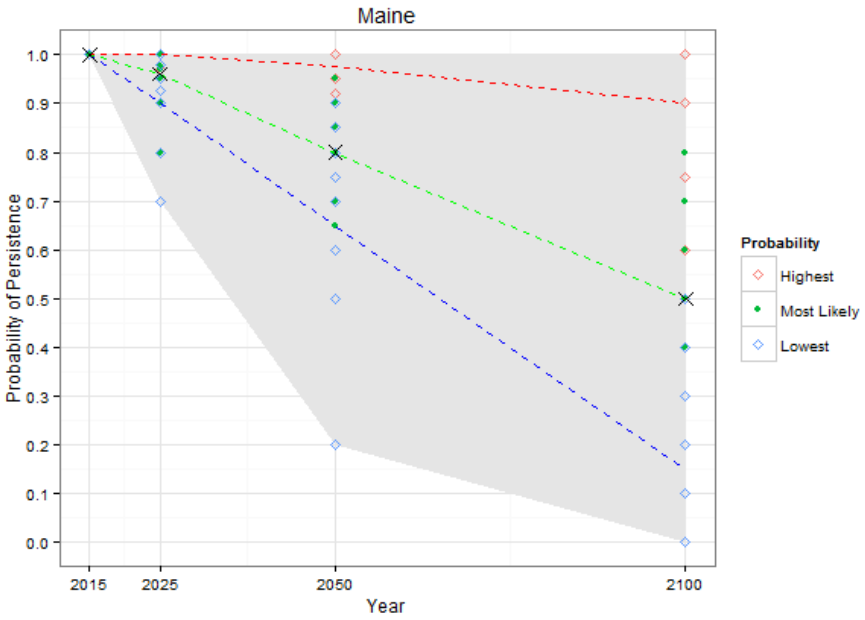


Figure 8. Lynx expert estimates of the probability that the Northern Maine Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Note: In Figure 8, above, and similar figures for the other geographic units, below, points for each of the 10 expert responses, for each of the three probability-of-persistence levels, i.e., highest, most likely, and lowest probabilities of persistence, are represented by the hollow red, filled green, and hollow blue points respectively. The black x mark is the median of the most l kely responses across the experts in each response year. The red, green, and blue dashed lines connect the median of the highest, most likely, and lowest probability of persistence responses across the experts in each response year. The edges of the grey area were defined by the extreme responses, i.e., the range from the largest of the highest probability of persistence responses to the smallest of the lowest probability of persistence responses. The median lines and grey area are provided as a summarizing visualization to aid comprehension of the experts' responses and their range, and should not be viewed as a substitute for individual responses or presented outside the context of the accompanying discussion.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - In response to public concern about widespread clearcutting in northern Maine, in 1989 the Maine Legislature passed the Maine Forest Practices Act (MFPA). The MFPA regulates maximum size of clearcuts (250 acres), separation zones between

clearcuts, harvest plans, and notification to the Maine Forest Service. Clearcuts are not banned, but require varying levels of state permits depending on their size. As a result, the number and acreage of clearcuts completed annually has declined substantially and have been replaced by various forms of partial harvesting (Sader *et al.* 2003, p. 349-350, McWilliams *et al.* 2003, p. 35). In the first decade following passage of the MFPA, the percentage of acreage clearcut in Maine annually declined from 40 percent to 4 percent (Simons 2009, pp. 45-46). The average size of clearcuts has been reduced from >125 acres (Maine Forest Service 1995) to <25 acres (Maine Forest Service 2003, 2005, 2007). Currently, partial harvesting comprises about 94 percent of acres cut annually in Maine (Simons 2009, p. 50). The total volume harvested, however, changed relatively little. The partial harvest that replaced clearcuts include a variety of silvicultural treatments, including both even-aged (e.g., shelterwood) and uneven-aged (e.g., selection) management that result in a wide range of residual stand conditions (Robinson 2006), which have important implications for lynx conservation. Foremost, snowshoe hare densities in partially harvested forests are on average about 50 percent lower (but range from 20 to 90 percent lower) than in regenerating conifer stands created by clearcutting (Robinson 2006, entire; Scott 2009, p. 109, Simons 2009 p. 83), thus reducing landscape hare density and presenting a challenge for future lynx conservation (Simons 2009, pp. 206, 209, 217; Simons-Legaard *et al.* 2016, p. 7-8; Simons-Legaard 2016, entire).

To harvest the same volume of wood annually, landowners must partial harvest many more acres than they would under former clearcutting silvicultural systems. The acres of forest harvested annually in Maine have increased from about 250,000 acres pre-MFPA to 550,000 acres post-MFPA (McWilliams *et al.* 2003, p. 35). Currently, 27 years after implementing the MFPA, much of the 10 million-acre northern Maine landscape has been influenced by partial harvesting. Extensive partial harvesting and aging of the spruce budworm-era clearcuts will reduce landscape hare densities (Simons-Legaard *et al.* 2016, 9-10). If the current landowners continue to harvest using similar methods at and similar rates, habitat for lynx will diminish by about 50 percent by 2030 (Simons-Legaard 2016, pp. 9-10). After 2030, projected outcomes for lynx habitat become more uncertain and depend on assumptions about habitat definitions and harvest rates. Lynx in Maine selected for regenerating, conifer-dominated forest (>75 percent conifer, Vashon *et al.* 2008, pp. 1490, 1492-1494). If one defines lynx habitat as stands having greater than 75 percent spruce-fir, then habitat will decline by about 50 percent by 2030 and remain at about at this level through 2060 (Simons-Legaard 2016, pp. 9,16).

These projections do not consider the next outbreak of spruce budworm. After being low for the last 20 years, spruce budworm numbers are again building toward epidemic levels in Maine, southern Quebec, and northern New Brunswick. Significant defoliation in Maine is expected to begin between 2018 and 2021 (Wagner *et al.* 2014). Although Maine research has clearly demonstrated that landowner response to the last outbreak resulted in unintended, positive benefits for lynx from one to three decades later, our ability to project what effects the next outbreak will have on lynx habitat is still limited. Land ownership has changed dramatically since the last outbreak. To reduce risk from spruce budworm, some financial investment owners may cut younger spruce-fir stands that still support elevated hare populations. Some may be less inclined to intensively manage for spruce-fir. It is unlikely that current landowners will use

widespread use of pesticides to control spruce budworm and herbicides to promote spruce-fir regeneration after stands are defoliated. The MFPA may serve as an additional constraint on motivation to clearcut infested stands, even with recently-enacted changes intended to reduce the regulatory burden for landowners. Landowner response to the pending outbreak will have important implications for the short- and long-term persistence of lynx habitat in the northern Maine unit (Simons-Legaard 2016, pp. 16-17).

Nor do these projections consider a substantial decline in snowshoe hare densities that has occurred in Maine. Snowshoe hare density declined by 69.3 percent from a period of high hare density in 2001-2006 (average of 2.1 hares/ha in regenerating conifer) to a period of lower hare density 2007-2009 (average of 1.0 hares/ha). This decline occurred across all forest stand types and across a broad geographic area of Maine (Scott 2009 p. 36) and the adjacent Gaspe region of southern Quebec (Assells *et al.* 2007, Scott 2009, p. 41-42). Hares remained at these lower numbers through 2013 (D. Harrison, University of Maine, unpublished data). If future hare populations remain low, then Maine habitats will have a lower capacity for supporting lynx.

Climate Change - The northern Maine unit is more vulnerable to snowpack loss because of the lack of elevational refugia (Siren *in* Lynx SSA Team 2016, pp. 15 and experts p. 37) and changes in snow conditions could further restrict their range (Hoving 2002, Hoving *et al.* 2005, Carroll 2007). Wildlife experts in Maine ranked lynx as highly vulnerable to climate change (>66 percent loss in species range/population and extirpation within 50 to 100 years) (Whitman *et al.* 2013, p. 19, 74). Similarly, Carroll (2007, entire) modeled Maine lynx population assuming non-cycling hare populations and snow conditions expected under intermediate to high emissions climate models (Kiehl and Gent 2004, entire). He predicted a 59 percent decline in the lynx population (the non-cycling hare population model) by mid-century because of climate change alone. Maine lacks elevational refugia for lynx under reduced snow scenarios (Carroll 2007, p. 1102), except for the mountains in western Maine where snow refugia may only persist as very small, isolated “sky islands” that would be unlikely to support lynx.

Climate change is affecting the Northeast, and the rate of change is faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46° C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Northeast climate models predict average winter temperature increasing 2.0°C (low emission) to 2.9°C (high emission) by mid-century and 3.1°C (low emissions) to 5.3°C (high emissions) by late century (Notaro *et al.* 2014). Largest increases in temperature are expected in northern Maine (A. Siren, Workshop Notes 2016, Rawlins *et al.* 2012) where temperatures may increase 4.5 to 5.0° F by 2050 (Fernandez *et al.* 2015, p. 3). In response to climate change, interest in wind development has escalated in northern and western Maine increasing threats to high elevation and potential spruce-fir refugia (Whitman *et al.* 2013). Climate conditions are currently at or falling below threshold values needed to support lynx in Maine.

If future trends in increasing temperature and decreasing snow occur, then lynx are unlikely to persist in Maine. Gonzales *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007) and predicted loss of forest and snow conditions able to support lynx in Maine by the end of the century. Although there are uncertainties about future climate warming, lynx populations in Maine are expected to recede northward and decline substantially this century (Vashon *et al.* (2012, p. 60).

Snow Duration. The current average snow duration in Maine is at or below the 4 month snow persistence thresholds believed needed to support lynx (section 4.1.1, Gonzales *et al.* 2007) and is projected to decline. Snow duration is project to continue to deteriorate. Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Snow duration is expected to diminish by 25 percent (low emissions) to 50 percent (high emissions) from current conditions by the end of the century (Hayhoe *et al.* 2006). Similarly, Notaro *et al.* (2014) projected an average decrease of 28 days (low emission) to 47 days of snow cover (high emissions) by the end of the century.

Snow Depth. The current average snow depth in northern Maine is at or below the 270 cm/yr. (106 in/yr) thresholds believed needed to support lynx (section 4.1.1; Hoving *et al.* 2005) and is expected to decline. By the end of the century, large areas of the Northeast will experience 15 percent (low emission) to 25 percent (high emissions) reduced snowfall (Ning and Bradley 2015). Similarly, by the end of the century Notaro *et al.* (2014) projected average snow declines in the North Atlantic Landscape Conservation Cooperative of 59 cm (31 percent) (low emissions) to 92 cm (48 percent) (high emissions) because a higher proportion of winter precipitation will fall in the form of rain rather than snow. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015).

Snow Quality. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015). Snow density and compaction (caused by wet, heavy snow or rain on snow events in winter) will continue to increase in the region in the future (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006, Karl *et al.* 1993).

Loss of Boreal Forest. Climate change is projected to cause a northward contraction of spruce-fir forest in the Northeast with potential negative consequences for both lynx and snowshoe hares (Gonzales *et al.* 2007, entire). Spruce-fir forest is expected to decline substantially in Maine and the Northeast (Ollinger *et al.* 2007 Beckage *et al.* 2008, Tang and Beckage 2010, Whitman *et al.* 2010, p. 12, Jacobson *et al.* 2009, p. 27) or disappear (Iverson and Prasad 2001, pp. 192-193, Prasad *et al.* 2007) because of climate change. Climate change is anticipated to increasingly fragment the boreal forest in northern New England (Iverson *et al.* 2008, Ollinger *et*

al. 2008, Whitman *et al.* 2013). Lynx habitat will decline as boreal forest diminishes (Simons 2009). Even under the lowest emissions scenarios, spruce-fir forest would be greatly reduced by 2100 (Williams and Liebhold 1997, Prasad *et al.* 2007), although some spruce-fir may persist at highest elevations (Tang and Beckage 2010) and along the eastern coast (Jacobson *et al.* 2009) where cooler conditions will prevail.

The spruce-fir forest type has come and gone from New England during the post-glacial period. It nearly disappeared from the Northeast during interglacial warming period 1000 years ago, then moved south into New England only in the past few centuries during the "Little Ice Age" (Schauffler and Jacobson 2002, DeHayes *et al.* 2000). Because of its sensitivity to climate and mobile nature, Iverson *et al.* (2008, p. 403) predicted a significant decline (low emissions) or the disappearance (high emissions) of the spruce-fir forest type in northern Maine in response to climate change.

Spruce (red, black, white) and balsam fir are the most important boreal forest conifer tree species in the Northeast and will be affected by climate change in different ways. Mechanisms of injury to spruce-fir include winter injury from freeze-thaw cycles, spring drought (because of reduced snowpack), and reduced seed germination (Perfect *et al.* 1987, Auclair *et al.* 2010). Thus, the range of spruce-fir is limited by summer heat and drought. Mohan *et al.* 2009 projected that suitable area for balsam fir would decline by 80 percent in 2100 under an average to high emissions scenario. In contrast, Ollinger *et al.* (2008) projected increasing growth rates for balsam fir and red spruce to mid-century, after which they would decline.

The timescale of the spruce-fir decline in the Northeast is difficult to predict because of the many variables that influence shifting of the forest species composition (emissions scenarios, the long lifespan of trees, slowness of tree dispersal, frequency of disturbance, competition from advancing hardwoods and invasive tree species, complex interactions with moisture, and synergistic effects with other pollutants). Arguments in favor of an accelerated decline include evidence that spruce-fir is already in decline (Seymour 1992, Simons 2009) and is being replaced in Maine by northern hardwoods (oak, pine, red maple). The decline of the spruce-fir forest type is accelerated by forest disturbances. A pending spruce budworm outbreak and frequent disturbance from forest management could accelerate conversion to northern hardwoods in northern Maine and eastern Canada (Flannigan *et al.* 2001, Gauthier *et al.* 2015). Other climate-related forest disturbances (forest pests, diseases) could further accelerate conversion to northern hardwoods (Iverson *et al.* 2008, p. 404).

In contrast, some authors note that trees migrate slowly and are long-lived. Therefore, a time lag may occur in shifting forest composition from spruce-fir to northern hardwoods (Mohan *et al.* 2009, Zhu *et al.* 2012). Some northern Maine industrial forest landowners could "adapt" to climate change by intentionally favoring spruce-fir (e.g., by plantations and use of herbicides). McWilliams *et al.* 2005 (p. 8) noted that balsam fir increased in Maine's forest inventory in the 2000s. Forest models projected increases in spruce-fir biomass over the next century because of partial harvesting and periodic budworm outbreaks, but did not take climate change into consideration (Simons-Legaard *et al.* 2013).

Finally, there is uncertainty concerning the influence of climate change on balsam fir, a short-lived, shade-tolerant, conifer that dominates much of the understory in the Acadian forest and is an important component of lynx habitat in the Northern Maine Unit. Climate change will influence precipitation and temperature, forest management strategies, and forest disturbance (fire frequency and spruce budworm), all of which will interact in complex ways to influence the spruce-fir forest at the southern edge of its range. Carter (1996), Iverson *et al.* (1999), and Goldblum and Rigg (2005) documented balsam fir growth rates and growth potential would decline under likely climate warming scenarios (~4 to 5 F degree temperature increase by the end of the century and reduced snow conditions). Some have projected the extirpation of spruce-fir forest types in the Great Lakes States (Scheller and Mladenoff 2005) and New England (Iverson and Prasad 2000). In contrast, balsam fir has prolific seed production following forest disturbance such as harvesting (Seymour 1992), and has proliferated under the current climate and forest management regime dominated by partial harvesting (Olson *et al.* 2013, entire). Balsam fir is a relatively short-lived tree (~100 years), and is unlikely to persist long if climate change affects seed and germinations rates. Given, anticipated climate changes, especially early snow melt and low spring precipitation, fir may increase for the next few decades but is unlikely to regenerate in a the future Maine forest (E. Simons-Legaard, University of Maine, pers. comm. May 31, 2015).

Vegetation Management - Habitat suitable for lynx is expected to decline in the future (see Regulatory Mechanisms section above). By 2020, all of the extensive areas that were clearcut in the 1970s and 1980s will be greater than 35 years of age and no longer support high hare densities. For the foreseeable future, partial harvesting will continue as the primary means of forest management. Although partially harvested forests with well-developed understory structure may provide foraging opportunities via increased prey access (Fuller *et al.* 2007), snowshoe hare densities are approximately 50 percent less in landscapes dominated by partially harvested stands (Robinson 2006, entire; Fuller and Harrison 2010). Thus changing forest management practices will continue to reduce landscape hare density below levels that can support lynx.

Sources of uncertainty concerning future habitat conditions in northern Maine include changes in forest policy, timber harvesting methods, changing timberland ownership, response to budworm outbreaks, and timber markets - all of which have occurred in the recent past and will undoubtedly shape forest management in the future (Simons-Legaard *et al.* 2016, p. 8). Currently, the landscape is owned primarily by financial investors who may be less inclined to intensively manage for spruce and fir after the next outbreak of the spruce budworm (Wagner *et al.* 2014).

The dramatic shift from clearcutting to partial harvesting presents a challenge for lynx conservation in this unit for the next several decades. Lynx, habitat is expected to peak and remain stable through about 2020 (Simons 2009, Simons-Legaard *et al.* 2016 p. 6). After 2020, aging of the former clearcuts and extensive partial harvesting are projected to result in a 50 to 65 percent decline in lynx habitat by 2032. Lynx habitat will decline from about 9.5 percent of

the landscape (current condition) to about 4.5 percent of the landscape (Simons-Legaard 2016). By 2032, the Northern Maine Unit may support less than half the lynx population as it does today (Simons 2009, p. 209, 217).

In the future, lynx habitat will be fragmented into smaller, isolated parcels, and will shift southward into areas occupied by bobcats and fishers where snow conditions are unlikely to support lynx (Simons 2009, Simons-Legaard *et al.* 2016, Simons-Legaard 2016). By 2022, the number of patches of high quality hare habitat will increase by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6). The proximity index of high quality habitat patches will decline by 78 percent within lynx home ranges. Although lynx habitat is peaking, fragmentation is diminishing its ability to support lynx (Simons-Legaard *et al.* 2016).

Beyond 2030 assumptions concerning future climate change, land ownership, and harvest rates introduce greater uncertainty. The most optimistic forest management models (greatest harvest rates, no climate change, no spruce budworm) project that lynx habitat will decline over the next few decades then gradually increase to about 10 percent of the landscape by 2060. The most most pessimistic models (lowest harvest rates, no climate change, no spruce budworm) project about 5 percent of northern Maine will have high quality hare habitat (Simons-Legaard 2016, entire), although the habitat will be much more fragmented and smaller patch size (Simons-Legaard *et al.* 2016).

Softwood plantations could offset losses in spruce-fir and become a form of adaptation to climate change. Jack pine plantations are extensive in adjacent New Brunswick (Etheridge *et al.* 2005, p. 1966). A forest company that has planted extensive spruce plantations in New Brunswick and recently purchased nearly 1 million acres of forestland in northern Maine where they are doing the same. Spruce plantations are becoming more common on this ownership in Maine, but not others. Stand structure and intensive management of plantations are highly variable (e.g., pruning, thinning, herbicide treatments), thus hare density and use by lynx vary (Roy *et al.*) Hares can achieved higher densities in plantations depending on the amount of lateral cover, but for shorter periods of time; ~10 to 17 years after cutting and planting in New Brunswick (Parker 1984, p. 163) and 15 to 25 years in Quebec (Roy *et al.* 2010, p. 585). This is in contrast to ~15 to 35 years in naturally regenerating spruce-fir stands after harvest (Simons-Legaard *et al.* 2016, p. 4). The future of plantations in the northern Maine unit is uncertain. Most investment landowners have short-term investment horizons and are unlikely to invest in plantations.

Natural stand-replacing disturbances are rare and infrequent and, other than spruce budworm outbreaks, are unlikely to significantly affect future habitat conditions (Hoving *et al.* 2004).
A spruce budworm outbreak is projected to reach epidemic proportions in 2018 to 2021. The epidemic has already affected 10 million acres of spruce-fir in southern Quebec, immediately north of Maine (Wagner *et al.* 2014, entire). The last outbreak in the 1970s and 1980s killed millions of acres of spruce and fir forests in the northern Maine unit. Maine's 5.8 million acres of spruce-fir stands across the state are at risk of some level of defoliation. The intensity of the

next outbreak is uncertain, although some project a weaker outbreak because spruce and fir trees are younger and less susceptible and there is a higher hardwood component in northern Maine forests (Wagner *et al.* 2014, p. 21-27). A typical outbreak lasts for a decade.

Forest management strategies for addressing the coming outbreak vary and include applying insecticides (although land area sprayed is expected to be small compared to the previous outbreak), pre-emptive cutting of mature spruce-fir before defoliation, stop precommercial and commercial thinning, and salvaging dead and diseased trees (Wagner *et al.* 2014, pp. 5-6). An aggressive forest management response (or not) will greatly affect future outcomes for lynx habitat (see section 5.2.1). The next budworm outbreak and subsequent forestry response is a disturbance agent that may accelerate changes in forest composition influenced by climate change, especially toward increased northern hardwood and reduced spruce-fir. The nature of landownership is greatly changed from the 1970s and 1980s, and landowner response is expected to be diverse depending on their objectives and investment horizons. The pending budworm outbreak cast additional uncertainty on the status of lynx habitat beyond 2030.

Climate change, forest management and budworm outbreaks will interact to influence the future trajectory of spruce-fir forest in Maine. All three variables have yet to be modeled simultaneously (K. Legaard, UMaine, personal communication). Assuming current forest management trends persist to the end of the century, spruce-fir dominated forest is expected to continue to decline (Legaard *et al.* 2013, entire). The combination of budworm-induced mortality and salvage harvesting will have a negative effect on spruce-fir (Legaard *et al.* 2013, entire). However, after a budworm outbreak the biomass and area of mixed-hardwood/softwood forest would be expected to increase through this century primarily because of regenerating balsam fir (see discussion above) (Legaard *et al.* 2013). Mixed forests having a high hardwood component are not believed to support high hare densities (Scott 2009, p. 109) or be preferred by lynx (Vashon *et al.* 2008, pp. 1492-1493). It is uncertain whether lynx can adapt to lower landscape hare densities associated with mixed hardwood-softwood forest. They may persist, but at lower densities as they currently do in the western units of the DPS. However, the probability of persistence is further diminished by deteriorating snow conditions and increased populations of bobcats and other competitors.

Fire Management - Suscept bility of the northern Maine unit to fire may be enhanced by a severe spruce budworm outbreak because of the amount of dead and dying spruce-fir (Stocks 1987), although there were no large fires after the last outbreak. Fire risk is currently very low in this unit and a continuous decrease in fire frequency is predicted with climate change in eastern Canada because of increased precipitation and decreased drought (Bergeron and Flannigan 1995, Flannigan *et al.* 1998). Climate is expected to become more variable during the next century (Gregory & Mitchell 1995; Gregory *et al.* 1997), which could create fire conditions in unusually dry years (Flannigan *et al.* 1998, p. 475). Maine's policy is to immediately suppress wildfire, thus large, stand-replacing fires are expected to be infrequent in this region. Notable large fires in Maine include a 3 million acre fire in 1825 and 200,000-acre fire in 1947.

Habitat Fragmentation - The future of the 10 million-acre, sparsely populated “North Woods” of Maine is highly uncertain and has been the subject of intense public debate (Baldwin *et al.* 2007). Land use and zoning in the state’s “unorganized townships” are the respons bility of the Land Use Planning Commission (LUPC) in the Maine Department of Conservation. The LUPC revised its Comprehensive Land Use Plan (De2010), and described principal values in guiding future land management decisions: maintaining working forests, provide for traditional recreational opportunities, protect high-value natural resources, and encourage long-term conservation. The North Woods has long been considered a public resource or “commons,” even though privately owned (Judd 2007, p. 9). This land was traditionally owned by a few large timber companies, but since the 1980s there has been rapid turnover in ownership largely by investments companies and subdivision of large parcels (Hagan *et al.* 2005). Financial investors, such as REITS and TIMOs focus on maximizing the asset value of timberlands and are increasingly likely to seek revenue from non-timber resources if they will generate a higher return. These new owners operate over relatively short time horizons (e.g., 5 to 15 years) and are willing to consider multiple means of monetizing their asset, including development and real estate sales (Legaard 2013, entire). If left unchecked, these pressures may continue to promote dispersed residential development throughout this region. Parcelization and subdivision has increased, particularly in the southern third of the jurisdiction (Maine Department of Conservation 2010, p. 72-73). The LUPC has limited ability to address stressors on Maine’s North Woods, including resale and subdivision trend. This trend is likely to continue into the foreseeable future and will make management of large, forested landscapes for Canada lynx even more difficult.

Historically, development has stayed mostly on the edges of the North Woods jurisdiction with exception of scattered seasonal dwellings and sporting camps in the interior, but this could change in the future. Between 1971 and 2005, the LUPC permitted 8,136 new dwellings in unorganized townships — an increase of 66 percent in the number of residences during this time period (Maine Department of Conservation 2010, p.80). Between 1971 and 2005, the LUPC issued 1,353 development permits for new uses scattered throughout the unorganized townships (Maine Department of Conservation 2010, pp. 97-99); most (42 percent) being recreational facilities (boat launches, campsites, gatehouses, recreational lodges). Most development has occurred in areas that abut organized communities and near public roads. Within the interior most development has occurred on long lakeshores and waterfront. However, the amount of hillside and ridge development is growing and this trend is likely to continue (Maine Department of Conservation 2010, p. 136), which will further fragment lynx habitat.

We have an incomplete understanding of the effects of outdoor recreation on lynx and their habitat (ILBT 2013, p. 80). Future trends in outdoor recreation in northern Maine are also uncertain (Vail 2007, entire). A portion of the North Maine Woods is a gated road system that encompasses about 3.5 million acres. Visitation by outdoor recreationists is currently about 175,000 per year and declining. Likewise, visitors to Baxter State Park and the Allagash Wilderness Waterway have declined (Vail 2007, p. 107). Aside from a vigorous discussion of a proposed national park or monument, national heritage area, or a master tourism plan for the area (Vail 2007, pp. 112-113), there is likely to be stagnant or declining participation in

traditional outdoor recreational activities in the future (Vail 2007, p. 107). Snowmobiling may be an exception because of declining snow (see climate change section). The effects of new or expanded downhill ski development on fragmentation of lynx habitat are expected to be minimal. Three alpine ski resorts occur within the unit on the southern margin of lynx habitat: Saddleback Mountain Ski Area in Sandy River Plantation near Rangeley, Sugarloaf Mountain Ski Area in Carrabassett Valley, and Sunday River Skiway in Newry and Riley Township. Further development of ski areas is unlikely in the western Maine mountains. Future trends in outdoor recreation and associated effects on lynx, hares, and their habitat are uncertain in the northern Maine unit

Within the last five years, two landowners developed concept plans for rezoning for large-scale development hundreds of house lots and resort development within the lynx critical habitat. One concept plan would construct 975 houses and two resorts on about 3,500 acres and a 363,000-acre conservation easement. A second concept plan would allow development on about 1900 acres of land and a 14,600 acre conservation easement. Although these developments have not been built, they may portend future trends in land use.

Energy production is emerging as a potentially significant economic factor in this unit, with grid-scale industrial wind power, biomass, biofuels, and other energy sources offering new opportunities to utilize natural resources. Wind energy resources are high within the lynx critical habitat (National Renewable Energy Laboratory 2010, http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mecitation ; last accessed 5/25/2016), and wind development in the lynx critical habitat are likely to accelerate in the foreseeable future. Mining is not a traditional land use but a large operation is being considered at one location in the lynx critical habitat. Extraction operations for gravel (for road building) are widely-scattered throughout the unit.

The lynx critical habitat is heavily roaded, particularly with forestry roads. While accurate numbers are difficult to obtain, approximately 1,500 miles of public roads and over 20,000 miles of private roads exist within unorganized areas of Maine (Maine Department of Conservation 2010). There has been discussion of an east-west limited access highway through northern Maine and extending Interstate 95 north from Houlton to Presque Isle, which, if constructed, would further fragment habitat (Maine Department of Transportation 1999, Beck *et al.* 2012, p. 38).

An increasing area of the lynx critical habitat area is likely to be placed under conservation easements that will limit future development and fragmentation of lynx habitat. Maine has the largest amount of land under easement of any state, and there are about 2 million acres of conservation easements in lynx habitat in northern Maine (Pidot 2011). Continued expansion of areas under conservation easement is uncertain and will depend on willing landowners and funding available for purchase of easements

All of development trends portend increased fragmentation of lynx habitat in the northern Maine unit. As habitat is fragmented, it will become increasingly difficult to influence landscape-scale forest management that could benefit lynx.

5.2.2 Unit 2 - Northeastern Minnesota

Expert Projections of Lynx Status

The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century (Lynx SSA Team 2016, pp. 37-38 and Figure 9, below). Near term drivers of the projected decline were reduced quality, quantity, and persistence of snow, competition from bobcats, disease (*e.g.*, lungworm, liver fluke, feline leukemia), and forest insects. Long term drivers of the projected decline were reduced the quality, quantity, and persistence of snow, competition from bobcats, loss of spruce-fir forests, wildfires, and climate change. Climate change was primarily associated with loss of boreal forest but could potentially also increase disease or insect outbreaks, and is likely to affect the amount of precipitation falling as good quality snow in the area of the state supporting lynx habitat. The connection to lynx in Ontario reduces the likelihood of local extirpation in this geographic unit, but the likelihood would increase if connectivity was compromised. Taking all factors into consideration (i.e., loss of boreal forest, competitions, disease and insect outbreaks, loss of snow), the experts projected the mean probability persistence to the year 2025 was greater than 90 percent, to 2050 was 80 percent (ranging from 60 to 90 percent), and would decline to approximately 35 percent (ranging from 10 to 60 percent) by 2100 (Lynx SSA Team 2016, pp. 37- 38).

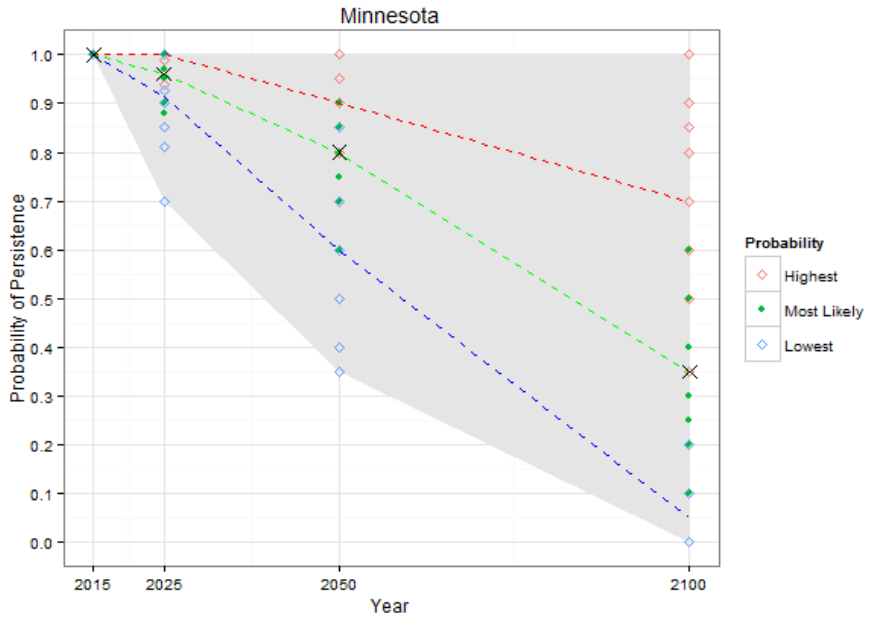


Figure 9. Lynx expert estimates of the probability that the Northeastern Minnesota Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - In Minnesota, the vast majority of lynx habitat that supports long-term persistent lynx breeding population is administered by the Superior National Forest. This area includes designated critical habitat (79 FR 54782). The SNF is currently implementing the 2004 SNF Plan (USDA 2004a), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat and the Superior National Forest has a long-term commitment for doing so. If the SNF continues to follow vegetation and wildland fire management and other applicable recommendations under the 2000 LCAS (or the updated 2013 LCAS or subsequent updates) in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. Management of lynx and its habitat on SNF land will remain in place until the forest amends or revises their individual LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended Forest Plans (LPMPs).

Although outside of areas considered to be core lynx area (i.e., where lynx are persistent and are reproducing) in the Great Lakes, the Chippewa National Forest and the Chequamegon-Nicolet National Forest Forest Plans also include direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs (USDA CNF 2004, USDA CNNF 2004).

Additionally, the Minnesota Department of Natural Resources (MN DNR) manages approximately 36 percent of the lynx habitat in this unit and private landowners make up about 16 percent of unit. Under the Sustainable Forest Resource Act of 1995 (revised in 2014), the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2013, entire; MFRC 2014, entire) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx (MFRC 2014, pp. 4-5). It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue. Private landowners, however, do not have an official commitment to land management. We cannot say with any certainty what proportion of privately owned land will follow those guidelines into the future, because following the guidelines is voluntary.

The NPS manages Voyageurs National Park, which is also within the Minnesota unit. Voyageurs National Park protects an area of 882 km^2, of which 534 km^2 (62 percent) is covered by forests and other uplands (Moen *et al.* 2012, p. 348), but does not have lynx specific direction in its management plan (NPS 2002, entire). The National Park consults with the FWS to consider the effects of any projects to lynx (NPS 2002, p. 26) and is anticipated to do so as long as the species is listed under the ESA. Lynx documented on and near Voyageurs National Park are probably transient animals (Moen *et al.* 2012, p. 348).

Approximately 1 percent of the Minnesota unit is managed by the Grand Portage Band of Chippewa, who has been actively working on lynx conservation since 2004. On-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire) and are expected to continue into the future.

In response to a 2008 court ruling, the MN DNR began to draft a plan to address incidental take of lynx that may result from otherwise legal trapping in Minnesota. This plan is still under development by the MN DNR and will be designed to reduce the likelihood of incidental take from trapping (LCAS 2013, p. 49).

Climate Change - The direct and indirect effects of climate warming are expected to affect lynx in Minnesota (Siren *in* Lynx SSA Team 2016, pp. 15 and Moen *in* Lynx SSA Team 2016, p. 19) and could further restrict their range. Since the time of listing, new information on regional climate changes and potential effects to lynx habitat has been developed (e.g., Danby & Hik 2007; Gonzalez *et al.* 2007; Knowles *et al.* 2006, Notaro *et al.* 2015), and this new information

suggests that climate change may be an issue of concern for the future conservation of lynx because lynx distribution and habitat is likely to shift upward in elevation within its currently occupied range as temperatures increase (Gonzalez *et al.* 2007, entire). Greatest stressors of climate change include diminishing snow depth, quality and duration; competition from bobcats and other carnivores, hybridization with bobcat (Schwartz *et al.* 2002); loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing forest conditions in Ontario.

Gonzales *et al.* (2007, entire) modeled distr bution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007, pp. 44-47) and predicted loss of forest and snow conditions able to support lynx in Minnesota by the end of the century. Notaro *et al.* (2015, pp. 1668-1669) projected changes in lake effect snowfall using downscaled climate models (Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4; Elguindi *et al.* 2011 and Giorgi *et al.* 2012 as cited in Notaro *et al.* 2015) for the Great Lakes Basin. Siren (*in* Lynx SSA Team 2016, p. 15) stated that climate models show an increase in lake effect snow in the eastern Great Lakes until 2050, with a decline later in the century, with an overall decline in the amount and duration of pack in the Midwest. Although there are uncertainties about future climate warming, lynx populations in Minnesota are expected to recede northward and decline over the next century (Lynx SSA Team 2016, pp. 37-38).

Lynx require at least four months (120 days) of continuous snow coverage (Gonzales *et al.* 2007, p. 7). Snow cover days of 1 inch or greater in northern Minnesota (1959 -1979) ranged from 130-160 days, of 6 inches or greater ranged from 85 to 130 days, of 12 inches or greater ranged from 50 to 100 days, of 24 inches or greater ranged from 10 to 30 days (Kuehnast *et al.* 1982, pp. 7-9). In the future, Notaro *et al.* (2015, p. 1675) projected a general reduction in the frequency of heavy lake-effect snowstorms during the twenty-first century, with the exception of projected mid-century increases around Lake Superior when local air temperatures are expected to remain low enough for precipitation to largely fall in the form of snow. The snow season in the Great Lakes basin is likely to become substantially compressed during the twenty-first century with dramatic increases in rainfall (Notaro *et al.* 2015, pp. 1676-1678). The Minnesota unit may be more vulnerable to snowpack loss due to lack of elevational refugia (Siren *in* Lynx SSA Team 2016, p. 15).

Normal annual snowfall from 1981-2010 in northeastern Minnesota ranged from 140 to 241 cm per year (55 to 95 in/yr.) http://www.dnr.state.mn.us/climate/summaries_and_publications/normals_snow_1981_2010.html, accessed 24May2016) and is projected to decline across the Great Lakes Basin (Notaro *et al.* 2015, p. 1675). Snow quality ("fluffiness") is projected to deteriorate in the Great Lakes. Notaro *et al.* (2015, pp. 1671-1674) projected a dramatic decline of Great Lakes ice cover that will become confined to the northern shallow lakeshores during mid-to-late winter by the end of the century. Ultimately, this leads to increased rainfall, not snowfall, as these projected reductions in ice cover and greater dynamically induced wind fetch lead to enhanced lake evaporation and total lake-effect precipitation (Notaro *et al.* 2015, pp. 1674-1678).

Climate change is projected to cause some northward contraction of boreal conifer forest in Minnesota (Gonzales *et al.* 2007, p. 16, 18) with some potential loss of habitat at the southern portion of lynx habitat in the state (Gonzales *et al.* p. 2007, p. 19). According to Frelich (*in* Lynx SSA 2016, p. 14) Minnesota is likely to lose boreal biome, potentially within the next 60 to 70 years, with unmitigated climate change. According to Gonzales *et al.* (2007, p. 8), the Superior National Forest is a potential refugia for lynx in the lower 48 states, however, when compared to other regions.

Vegetation Management - Vegetation management conducted under the Forest Plan currently will likely continue into the future on Forest Service lands in Minnesota. These activities include timber harvest, such as thinning, clear-cutting, shelterwood, partial cut, and uneven-aged cutting; wildlife restoration projects that involve tree cutting, shearing, burning, seeding, and planting; prescr bed burning for ecological purposes, hazardous fuel reduction, and site preparation; mechanical site preparation.

Vegetation, timber, and minerals management authorized under the Forest Plan has the potential to adversely affect lynx and lynx critical habitat by reducing habitat quality for denning, foraging, and dispersal; disrupting travel, resting, and foraging patterns; disturbing denning females and reducing habitat quality for lynx prey species, especially snowshoe hare. Depending on the timing, frequency, intensity, extent, amount, or other conditions, impacts may be variable among similar projects. Using the LCAS as a basis, the Forest Plan has incorporated a number of components that would reduce the risk of those impacts into the future. We expect that management direction for lynx addressing vegetation management on national forest system lands will be incorporated into the revised or amended future plans, using LCAS as a basis.

Future Forest Plan revisions will likely maintain broad direction to design and implement vegetation management projects to maintain or restore conditions for lynx foraging and denning habitat and to maintain or improve juxtaposition of required habitat types and connectivity.

Over the long term, the Forest Plan will alter vegetation patterns on the landscape. Suitable hare habitat was predicted to decrease over time with implementation of the Forest Plan, but has actually increased since 2004 (USFWS 2011, p. 51). Management activities that create unsuitable conditions for hare generally include clear-cut and seed tree harvest, and might include management-ignited fire, mechanical site preparation, salvage harvest, and shelterwood and commercially-thinned harvest, depending on unit size and remaining stand composition and structure. Suitable hare habitat is predicted to remain above the range of natural variation, which is essentially a description of conditions that existed prior to European settlement (1600 – 1900 A.D.) of the area (USDA 2004b, p. 105). Further, unsuitable habitat for lynx would vary only slightly with continued implementation of the Forest Plan and would remain distinctly below the maximum of 15 percent unsuitable in a decade prescribed in the LCAS and incorporated into the Forest Plan. Current (2010) unsuitable habitat levels are below what was predicted in the 2004 (USFWS 2011, pp. 51-52). Because suitable habitat on National Forest lands alone is

such a high percentage within LAUs and the Superior National Forest is the majority landowner within most LAUs, we expect that in the future, the Forest would not approach the LCAS maximum of 30 percent of lynx habitat on all ownerships in an unsuitable condition within an LAU at any time, which would be ensured by corresponding guidance in the Forest Plan.

Wildland Fire Management - Unlike the Maine unit, the susceptibility of the Minnesota unit to fire may be reduced by periodic spruce budworm outbreaks. Measurable defoliation due to spruce budworm has occurred in Northeastern Minnesota continuously since 1954 (MN DNR http://www.dnr.state.mn.us/fid/july2014/articles.html) and is expected to continue into the future. Modeling to evaluate the relative strength of interactions between spruce budworm outbreaks and fire disturbances in the BWCA showed that budworm disturbance can partially mitigate long-term future fire risk by periodically reducing live ladder fuel within the forest types of the BWCA but will do little to reverse the compositional trends caused in part by reduced fire rotations there (Sturtevant *et al.* 2012, pp. 1286-1292).

The Superior National Forest manages for wildfires through preventative measures such as fuels reductions, but does not manage for wildfires in the BWCAW. Natural successional changes and those associated with natural phenomena, such as wildfire or windstorms, are and are expected to continue to be the dominant force in ecosystems on the BWCAW.

Habitat Fragmentation - Ravenscroft *et al.* (2010, p. 329) considers northeastern Minnesota forest landscape as largely un-fragmented. The BWCAW remains intact and contiguous with Canada. Within the SNF, natural disturbances and vegetation management activities make up most of the annual human-caused fragmentation in actively managed portions of the Forest. These areas typically re-vegetate within three to five years, depending on the forest type and number and type of activities (USDA 2011, p. 119). The Forest Plan (USDA 2004a, Appendix E) provides direction on limiting lynx habitat fragmentation and the Forest actively consolidates habitat through land acquisitions and exchanges.

5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Expert Projections of Future Lynx Status

Because of its connectivity to lynx populations and habitats in Canada, its large geographic extent, and the relatively large number and broad distribution of resident lynx it is thought to support, future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely (Lynx SSA Team 2016, pp. 25-34). When considering the probability that this unit would continue to support resident lynx in the future, experts noted that despite projected losses of favorable forest and snow conditions, climate models project that some boreal forest will persist in this unit and that it will maintain some areas of suitable snow into the future. Experts also noted that lynx in this unit primarily occupy public lands, which are actively managed for lynx into the future. Experts also considered recent and projected future increases in wildfire frequency, size and intensity.

As for most other geographic units, all experts indicated an initially high and subsequently decreasing probability of the persistence of resident lynx in this unit, with increasing uncertainty over time, but a higher probability of persistence at all time frames than other units. All experts predicted near-term (year 2025) persistence probability >= 95%, mid-century persistence at 70% to 100% (median = 90%), and end-of-century persistence probabilities >= 50% (median = 78%) (Figure 10, below).

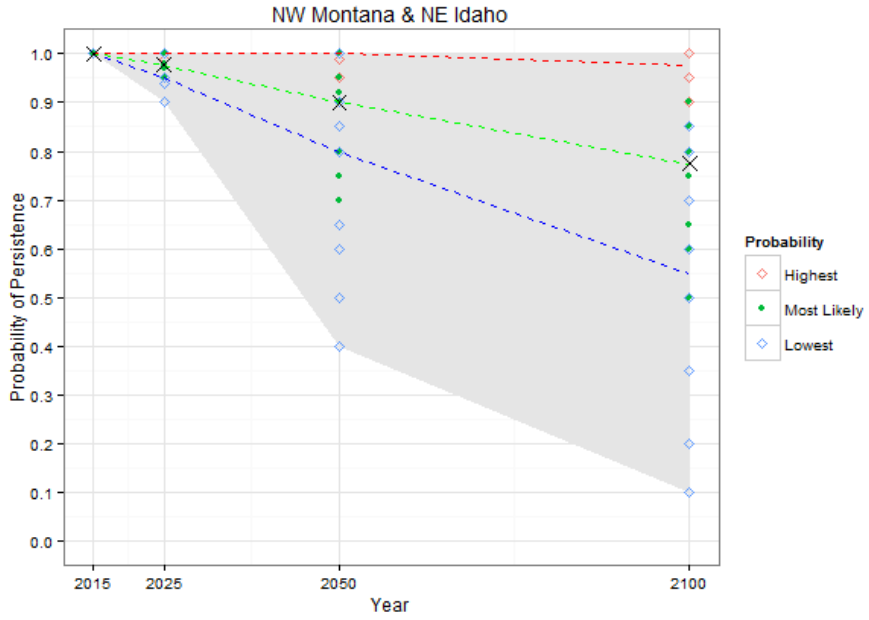


Figure 10. Lynx expert estimates of the probability that the Northwestern Montana/Northeastern Idaho Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Overall, experts assigned a higher probability of persistence in this unit compared to the other geographic units. Most lynx habitats in this unit occur on federal lands that are managed for lynx conservation, but one expert noted that little has been done to document whether lynx are responding to this management. The recent sale of large tracts of private commercial timberlands in the central part of this unit to The Nature Conservancy has increased protection for lynx via conservation easements managed for lynx. Habitats in some areas should improve in the near future as previously cut or burned areas mature into dense stands. Unlike the Maine and Minnesota geographic units (but similar to most other western units), high elevations in this unit could buffer the effects of climate change by providing for the upslope migration of lynx habitats and snow conditions that climate models predict. However, this would result in even patchier and more isolated islands of habitat in high elevation areas that would be more prone

to extirpation due to catastrophic or stochastic events. Competition from coyotes and bobcats seem to be less of a concern for this unit.

This unit has unimpeded connectivity with Canada, but some experts questioned whether this geographic unit depends on intermittent immigration of lynx from Canada, and whether the historic lynx population cycles in Canada believed to have fueled such immigration are still occurring or will into the future. There doesn't appear to be much demographic input from recent cycles. There is evidence of lynx from this unit moving north into Canada, but little evidence of demographic interactions among the three subpopulations (Purcell Mountains, Seeley Lake, and Garnet Mountains) in this unit. Experts noted that the Garnets Mountains subpopulation at the southern end of this unit may have recently become extirpated.

Discussion among experts indicated that fire was more of a concern for this area. Increased fire extent and severity or other catastrophic events and small subpopulation effects in separated mountain ranges could affect lynx persistence in the future in some parts of this unit. Fire exclusion in this area for the last 100 years likely resulted in the accumulation of fuels; however, this unit may have a reduced probability of a catastrophic fire over time because of recent changes in management and recent fires that may have reduced fuels. Out to the year 2050 and beyond, some experts felt there may be more pressure on lynx populations in this unit from continued increases in fire extent and severity. Other experts expressed a different opinion of the overall effect of fire in this unit, indicating that it may actually improve habitat over time, and that whether fires improve or degrade habitat depends on the frequency, intensity, size and spatial extent of future fires.

Experts discussed the possibility for increased precipitation and warmer temperatures in this unit because of climate change, and how this might affect lynx habitats. Boreal/subalpine forest may move up in elevation as described above; however, experts expected a shift in forest composition and diminished lynx habitat quality in future with climate change. It is unknown how much the distribution of dry ponderosa pine (non-habitat for lynx) will increase with climate change, but it is likely to happen at some level. One expert cautioned that some climate modelers estimated that vegetation will lag about 50 years behind the projected changes in temperature and precipitation. Snow levels in lower elevation areas are already decreasing in some areas, which could lead to smaller areas for lynx to use in winter in the future.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - Federal, State, and Tr bal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Because most (84 percent) of this geographic unit consists of federal lands, the regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations in this unit. When Forest Service, Park Service, and BLM management plans are revised or amended, they require opportunities for public participation in accordance with several statutes (e.g., the National Environmental Policy Act [NEPA], National Forest Management Act [NFMA], National Parks and

Recreation Act, Federal Land Policy and Management Act [FLPMA]) (USFWS 2014 pp. 26-34, also see 3.1, above). If plan amendments or revisions may affect listed species, management agencies must consult with the Service in accordance with section 7 of the ESA. If in the future the lynx DPS is determined by the Service to be recovered and the protections of the ESA no longer necessary (i.e., if the DPS is removed from the *Federal Lists of Endangered and Threatened Wildlife and Plants*), the ESA requires the Service, in cooperation with the States, to monitor the DPS for a minimum of five years to assess its ability to sustain itself without the ESA's protective measures. If, within the designated monitoring period, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (BLM 2004a, pp. 2-3; USFS 2007, Attachment 1, p. 2). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore the capacity of the areas that historically or recently supported resident lynx populations, including the Northwestern Montana/Northeastern Idaho Geographic Unit, to continue to do so in the future.

On non-federal lands (about 16 percent of this unit), as described above (sections 3.1.1 and 4.2.3, Habitat Status), recent acquisitions and conservation easements on some of the private lands in this unit will also reduce the likelihood of future adverse impacts to important lynx habitats. Similarly, the MTDNRC HCP includes a 50-year commitment to manage most (64

percent) State lands in this unit to conserve lynx foraging, denning, and connectivity habitats. Additionally, the Confederated Salish and Kootenai Tribe's objective to manage wildlife and habitats on the Flathead Reservation for future generations (section 3.1.2, Tr bal Management, above) suggests continued management to conserve lynx habitats on Tribal lands.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will continue to support resident lynx into the future.

If the DPS were to be delisted in the future, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.3, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 41). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely compromising this unit's continued ability to support resident lynx populations.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, and to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on future lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of these landscapes to continue supporting resident lynx may be compromised, and lynx populations may be unable to persist until favorable vegetation conditions return. This is especially true where habitats and populations are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much if not all of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced (as is suspected) by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will reduce this geographic unit's ability to continue to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx populations in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears l kely that continued climate warming will reduce future habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal and most non-federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.3, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current federal management restricts, with few exceptions, fire management (fuels reductions,

prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.3, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although this increased wildfire activity does not appear to have diminished this unit's current ability to support resident lynx, it could do so in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distr bution of higher-quality habitats and potentially compromising this unit's ability to support a resident lynx population until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.3, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier

anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – As described above and in section 4.2.3, maintaining connectivity between this geographic unit and lynx populations in Canada is thought to be important, although it is uncertain if or to what degree immigration of lynx from Canada is essential to the persistence of lynx in this unit. A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected.

Although the extent to which this factor may influence lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area (λ = 0.92, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. If this growth rate was applied continuously to a hypothetical resident population of 250 lynx (the midpoint of the range in the number of resident lynx this geographic may support based on expert opinion [Lynx SSA Team 2016, p. 41]), the population would decline to 100 lynx after 11 years, about 50 lynx after 20 years, and roughly 20 individuals after 30 years. Vulnerability to demographic, environmental, and genetic stochasticity would increase as lynx numbers decreased, resulting in an increased l kelihood of functional extirpation of lynx from this unit. However, as noted above, the lynx population in the Purcell Mountains in the northwestern part of this unit was estimated to be increasing (λ = 1.16, 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) over the last four years of the period for which the Seeley lake population was estimated to be declining. In the absence of information on historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.4 Unit 4 - North-central Washington

Expert Projections of Future Lynx Status

Compared to the previous units, most expert graphs showed a lower probability of persistence for this unit over the short term, and then lower probability of persistence along with increasing uncertainty by 2100, reflecting a more pessimistic outcome for this unit compared to previous units (Figure 11). Experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), and mid-century persistence at 30% to 80% (median = 70%). All experts predicted end-of-century persistence probabilities less than 50%, with a median of 38%, by 2100 (Figure 11). However, one expert predicted an increase in persistence probability by mid-century as habitats impacted by recent large-scale fires regenerate into optimal hare-lynx habitat.

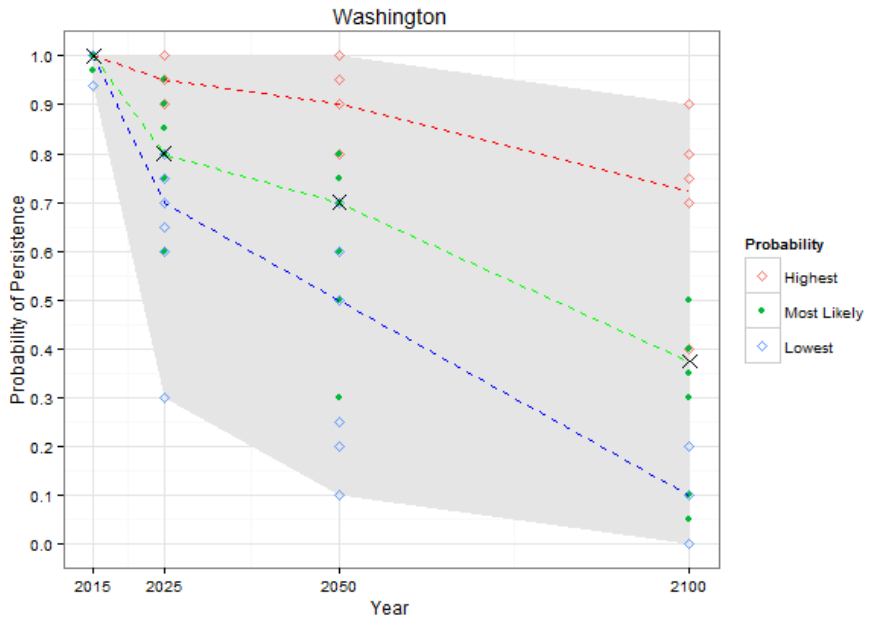


Figure 11. Lynx expert estimates of the probability that the North-central Washington Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

The probability of lynx persistence in this unit could decrease sharply over the next 10-20 years because of extensive recent fires in lynx habitats and the time needed for these areas to regenerate back to good hare/lynx habitat. After that, the probability could rebound (or decline more slowly) over the longer term as these large areas return to prime habitat providing high hare densities. The current small population is likely at greater risk of extirpation because of stochastic events, particularly if large fires in lynx habitat continue to occur in the near future as they have in the recent past. A small population also could be more susceptible to disease, though none has been documented among lynx in this unit. Experts discussed the extent to which small lynx populations could be reduced before they would become highly susceptible to stochastic demographic effects. It was suggested that 15-20 breeding individuals might be the minimum needed to avoid such susceptibility. Unimpeded connectivity between Canada and the Okanogan area of this unit could allow lynx to repopulate currently-unsuitable areas after the habitat recovers. Lynx in this unit are l kely the southern portion of a larger population in Canada, not really a separate, isolated small population. Factors that influenced expert

persistence probabilities for this unit included fire, habitat loss, and the future loss of favorable snow conditions predicted by climate change models.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - As stated previously, it appears that, currently, adequate protective regulatory mechanisms are in place in this geographic unit. Looking to the future, relative to the regulatory risks to lynx, we do not anticipate the existing regulatory protections for lynx to diminish. We anticipate that either the CA will remain in place (and/or be extended), or the OWNF and CNF will revise or amend their respective LRMPS incorporating direction for lynx management similar to what has occurred with other 18 National Forests in Idaho, Montana, Utah, and Wyoming. These 18 National Forests amended their respective LRMPs with lynx management direction known as the Northern Rockies Lynx Amendment (NRLA) in 2007. The NRLA incorporated management recommendations from the LCAS, with modifications based on the advent of new information pertaining to the management of lynx. Currently, both the OWNF and CNF are in the process of amending or revising their LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended LRMP. Also, as discussed previously, the WADNR has developed and is implementing its 2006 Lynx Plan. The WADNR commits to implementing the 2006 Lynx Plan until lynx are delisted or until 2076, whichever is shorter (WADNR 2006, p. 6). Thus, it appears the regulatory future of lynx management, and thus, lynx habitat management, is largely secure on both federal and state managed lands within Washington State.

Climate Warming - The one risk factor identified by the LCAS over which the Forest Service, or the WADNR for that matter, has little ability to control or influence is climate change. Climate change was identified by the panel of lynx experts convened during development of the Canada Lynx Expert Elicitation Workshop Report to potentially represent the greatest threat to the long-term persistence of lynx (Lynx Workshop Report 2016, p. 56).

Potentially further exacerbating the recent losses of lynx habitat from fires is climate change. Climate change may affect fire return intervals and severity as well as the quality and depth of snow within lynx habitat. Westerling *et al.* (2006, pp. 942-943) compiled information on large wildfires in the western U.S. from 1970-2004 and found that large wildfire activity has increased significantly from the mid-1980s with large-wildfire frequency, longer wildfire duration, and longer wildfire seasons. The greatest increases occurred in high elevation forest types including lodgepole pine and spruce fir in the northern Rockies (i.e., lynx habitat). They also found that fire exclusion had little impact on natural fire regimes. Rather, climate appeared to be the primary driver of increasing wildfire risk. As stated previously, Koehler's (1990, p. 847) estimated adult lynx density of 2.3 lynx/100 km^2 was obtained in an area supporting high quality lynx habitat in the Meadows area of north central Washington (at least relative to other lynx habitat in Washington). Much of the lynx habitat in the Meadows was impacted by the recent large, stand replacing fires in the Cascades, resulting in further fragmentation of lynx habitat in the northern Cascades. Thus, the lynx densities Koehler observed in his study area may not be

currently supported, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines.

Additionally, relative to the persistence of Washington's lynx population, during the lynx expert elicitation workshop several of the lynx experts expressed concern that should more wildfires occur within the next 10 years and result in losses of lynx habitat similar to the impacts caused by the recent wildfires, such wildfires could result in the functional extirpation of lynx in Washington. The experts expressed heightened concern of functional extirpation of lynx in this geographic unit from wildfires due to its small size and current lynx population (Lynx Workshop Report 2016, p. 27). However, the experts felt the potential extirpation of lynx, should it occur from a large catastrophic wildfire(s) (or other mechanisms such as insect outbreaks), may be ameliorated to some extent due to Washington's juxtaposition and connectivity to Canadian lynx populations. The experts felt that lynx immigration from Canada may rapidly recolonize Washington as the habitat recovers from fires or other impacts (Lynx Workshop Report 2016, p. 43). Climate change, in addition to potentially affecting fire return intervals, fire severity (intensity, size), and insect outbreaks, is likely to affect the amount of precipitation falling as snow at elevations typically supporting lynx habitat in this geographic unit.

Lynx survive in areas with cold, snowy winters providing deep, fluffy snow (78 FR 59443) that gives lynx competitive advantages over other competitors and predators of lynx, as well as providing the conditions supporting the lynx's main prey, the snowshoe hare, which can comprise as much as 97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448).

Climate change may impact the quantity, quality, and temporality of snow in the Cascades. Mote (2003, pp. 272, 274), who evaluated temperature trends in the Pacific Northwest using data collected by weather stations from 1930 to 1995, determined that the temperature increased in the Pacific Northwest, and more precipitation fell in the spring and summer months, especially at elevations below 1,800 m (5,900 ft). Additionally, Mote (2003, pp. 2-3) determined that an increasing temperature and precipitation trend from 1950 to 2000 is correlated with a 40 percent decrease in the snow water equivalent in the Cascades. Mote *et al.* (2005, p.45) determined that the Cascades are very sensitive to temperature changes, with large increases in temperature potentially resulting in significant declines in snowpack. Corroborating Mote's speculation, Stoelinga *et al.* (2010, p. 2474) determined that the Cascade snowpack has declined by up to 40 percent in the latter half of the twentieth century, which resulted from increased temperatures. Furthermore, predicted continued increasing temperature changes of 2° C to 5° C over the next century are expected to cause further and accelerated losses in snowpack in the Cascades (Mote *et al.* 2005, p. 48). Continued declines of snowpack in the Cascades through 2025 are predicted to range from 9 percent (Stoelinga *et al.* 2010, p. 2486) to 29 percent (Elsner *et al.* 2010 *cited in* Stoelinga *et al.* 2010, p. 2486), which may also affect lynx densities supported in the Cascades. Finally, some of the best lynx habitat in this geographic unit occurs on plateaus that may be more vulnerable to impacts of climate change because of the absence of higher elevation areas to which habitats and lynx could migrate in response to climate warming (Lynx Workshop Report 2016, p. 42). Thus, in addition to the recent losses of

lynx habitat to large wildfires, coupled with increasing wildfire risk, the potential for the Cascades to support a viable lynx population may be further reduced due to decreasing quantity and quality of snow.

Similar to the potential effects of wildfires on the persistence of the lynx population in this geographic unit, the lynx experts identified climate change relating to loss of favorable snow conditions as a significant factor potentially affecting the long-term persistence of this population (Lynx Workshop Report 2016, pp. 43-44). Taking all factors into consideration (i.e., catastrophic wildfire, insect outbreaks, loss of snow), the experts felt the probability of this population persisting to the year 2050 most likely ranged between approximately 60 percent to 80 percent, declining by the year 2100 to approximately 30 percent to 50 percent (Lynx Workshop Report 2016, p. 43).

5.2.5 Unit 5 - Greater Yellowstone Area

Expert Projections of Future Lynx Status

The expert graphs for this unit were widely variable and had different outcomes and high uncertainty at all time frames. Experts predicted near-term (year 2025) persistence probabilities of 10% to 70% (median = 52%), and mid-century persistence at 15% to 60% (median = 35%). All experts predicted end-of-century persistence probabilities less than 50% for this unit, with a median of 15%, by 2100 (Figure 12). This was the only unit for which most experts believed the present probability of persistence is low (i.e., that it is uncertain whether this area currently supports a resident lynx population). Some experts increased probability of persistence into mid-century as the 1980s-era fires regenerate into hare/lynx habitat, and with the poss bility of continued immigration of lynx from Colorado. Other experts project a 10% to 20% probability of persistence by 2100. One reason given for wide variability in responses is because of the uncertainty whether a population currently exists. There were wide confidence intervals around the probabilities for all time periods for this area.

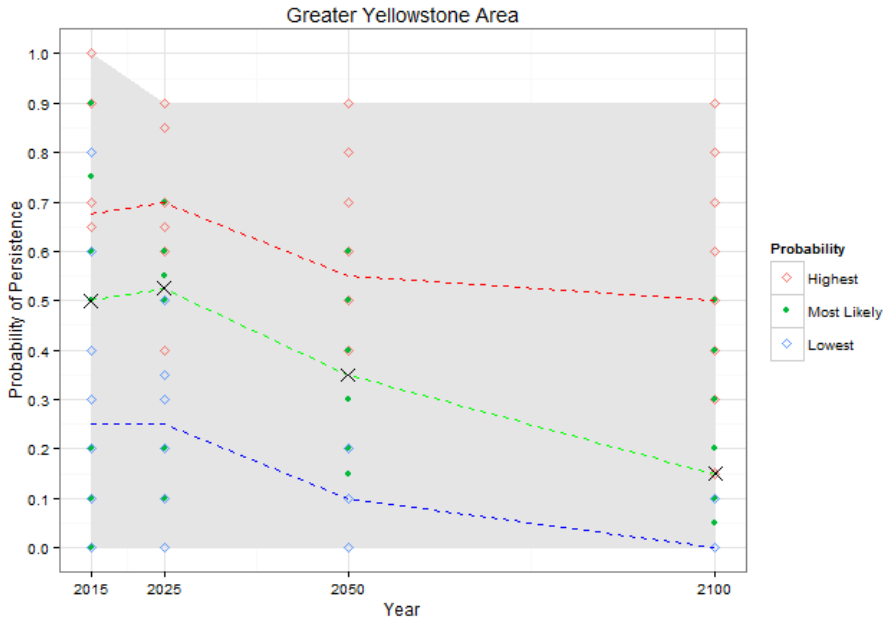


Figure 12. Lynx expert estimates of the probability that the Greater Yellowstone Area Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Current and future factors expressed by experts as influencing probability of persistence for this unit included small population size, forest disease and insect pests, and fire. Some experts doubt that the GYA unit currently supports a resident breeding population of lynx. Experts indicated that climate models predict that some parts of the GYA unit could provide refuge from climate change impacts because of their high elevations and potential to maintain winter snow levels into the future. Summer conditions in this unit, however, could be drier in the future, resulting in increased fire frequency, extent and intensity, and additional temporary habitat loss. However, regeneration of these areas and the extensive areas that have burned in the recent past may provide good habitat over the next several decades. Lynx immigrating to this unit from Colorado could occupy such improved habitats in the near future. Colorado lynx have made exploratory movements into the GYA in summer months, and analysis of available data could improve our understanding of Colorado lynx movement into and use of the GYA. It is possible that lynx from Colorado are maintaining or could maintain lynx in GYA.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - As noted above in section 5.2.3, federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Federal lands account for over 97 percent of this geographic unit; therefore, regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations. Also as described above, revisions or amendments to federal management plans require opportunities for public participation in accordance with NEPA, NFMA, National Parks and Recreation Act, and FLPMA (USFWS 2014 pp. 26-34; also see 3.1, above) and consultation with the Service in accordance with section 7 of the ESA. If the DPS were to be recovered and delisted in the future, the ESA requires a minimum of five years of monitoring to assess its ability to sustain itself without the ESA's protective measures. If, during that time, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (USFS 2007, Attachment 1, p. 2; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore potential lynx habitats in this geographic unit in the future.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support

conservation and restoration of lynx habitats in this unit and improve the likelihood that it will support resident lynx into the future. Because non-federal lands make up such a small proportion of this geographic unit, we believe it is unlikely that regulatory mechanisms on those lands will influence this unit's future ability to support resident lynx.

If the DPS were to be delisted in the future, State-managed trapping could resume in this geographic unit. We expect that would occur only if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.5, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 46). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely further compromising this unit's ability to support resident lynx populations, which is already questionable.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, including the extensive fires in Yellowstone National Park in 1988, which burned over one-third of the park. Climate warming has also been linked to increased frequency

and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of landscapes in the GYA to support resident lynx may be further compromised, and resident lynx may be unable to persist until favorable vegetation conditions return. This is especially true where potential habitats are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced by intermittent immigration from the north, and if climate change diminishes the l kelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will further reduce this geographic unit's ability to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx and habitats in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears l kely that continued climate warming will further reduce habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.5, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.5, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although the extent to which increased wildfire activity has impacted this unit's current ability to support resident lynx is uncertain, such impacts may become more likely in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand- initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support resident lynx until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.5, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – This geographic unit is not directly connected to lynx populations in Canada or elsewhere in the DPS range, although lynx released into Colorado have dispersed northward into and through this unit. There is little evidence of intermittent

immigration into this unit during past irruptions of lynx from Canada, as has been documented in other parts of the contiguous U.S. Nonetheless, as elsewhere in the DPS, immigration may influence the persistence of resident lynx in this unit. If continued climate warming or other factors further reduce the chances that dispersing lynx will reach this unit and contribute to its demographic and genetic health, either through habitat loss and fragmentation in potential dispersal corridors or declines in the amplitude of northern hare and lynx population cycles, the l kelihood that the unit will support resident lynx in the future may also decline. However, as in Unit 3 above, because we lack information of historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.6 Unit 6 - Western Colorado

Expert Projections of Future Lynx Status

The majority of the experts suggested an initially high probability of persistence in Colorado, declining gradually with increasing uncertainty through the end of the century. Experts predicted near-term (year 2025) persistence probabilities of 60 percent to 100 percent (median = 90 percent), and mid-century persistence at 50 percent to 85 percent (median = 80 percent). Experts predicted end-of-century persistence probabilities of 20 percent to 70 percent for this unit, with a median of 50 percent, by 2100 (Figure 13).

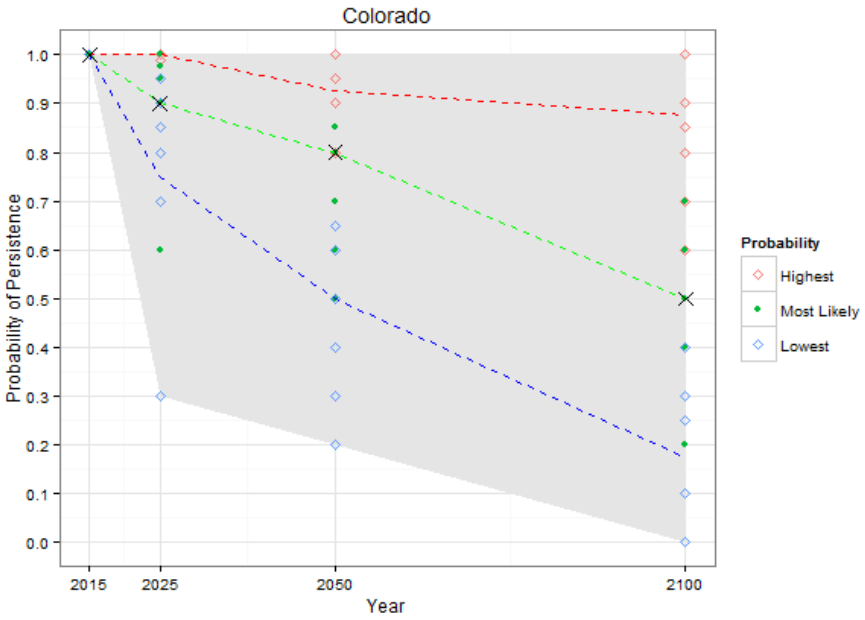


Figure 13. Expected probability of persistence for the Western Colorado Geographic Unit at present, 2015, and in 2025, 2050 and 2100.

Some experts indicated that beetle kill and fire could potentially create poor habitat conditions in large areas of this unit by mid-century, but that regeneration after these impacts could result in good lynx/hare habitats. Others expressed uncertainty about whether fire and insect impacts would be temporary or permanent, especially considering climate change and the potential for conversion from boreal/subalpine forests to other forest types. Although 8 of 10 experts graphed 50 percent to 70 percent probability of persistence at 2100, during subsequent discussions, several expressed greater uncertainty about whether resident lynx will persist in the unit at the end of the century. Higher-quality lynx habitat occurs primarily in two areas and is patchily-distributed. Lynx in this unit may occur as several smaller, relatively isolated subpopulations, which are likely more vulnerable to stochastic events. This unit's relative isolation may limit exchange with other lynx populations, increasing the likelihood of genetic drift and reducing the chance of demographic rescue or recolonization if lynx in the unit become extirpated. There was discussion about whether ski areas may affect daily movements of lynx, and hares may be declining in ski areas. Ski areas tend to expand and may, therefore, have larger impacts on lynx in future. There is some evidence of lynx using ski areas in summer months but avoiding them during the ski season. It is uncertain whether ski areas may affect genetic connectivity within the Western Colorado geographic unit. Two-thirds to three-quarters of the lynx in this unit are in the southern portion of the range in the San Juan Mountains. There is a large area (Weminuche

Wilderness) in Colorado that has not been well surveyed for lynx, so it is possible that lynx also could be using that area.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - Regulatory mechanisms for the conservation of lynx in the Southern Rockies consist of seven amended USFS management plans in south-central Wyoming, and Colorado. We concluded that the Southern Rockies Lynx Amendment substantively reduced the inadequate regulatory mechanisms by addressing the major adverse impacts of Forest Service land management on lynx (Service 2008, p 70-71). Lynx habitat on all other ownerships makes up the remaining 15 percent of lynx habitat in Colorado, of which, only five percent is in federal ownership. Other ownerships include state, county, municipal, etc., and private lands. The BLM resource management plans have not been amended to include conservation specifically for lynx and, with a few exceptions. Lynx habitat on BLM ownership mostly consists of narrow forest extensions connected to larger blocks of habitat on adjacent USFS lands. Generally these extensions are insufficient on their own to support a lynx home range. However, the Gunnison Field Office is the only BLM unit that contains sufficient habitat to map and identify LAUs.

The State of Colorado manages lynx as a state endangered species C.R.S. 33-2-105, prohibiting take of the species with exceptions for protection of human life (C.R.S. 33-6-205 and incidentally during depredation management (not caused by lynx) [C.R.S. 33-6-207].

Climate Change - ILBT (2013 p. 61) – “Climate change generally is expected to result in warmer winters, earlier spring snowmelt, and a reduction in the extent of snow cover in the southern Rockies. McKelvey *et al.* (2011 entire in ILBT 2013) used a variety of climate models to predict snow depth and the persistence of spring snow across the western United States. The models predicted an overall decline in persistent snow of 40 percent, but large areas of persistent snow would continue to be retained late in the 21st century, including the high elevations of Colorado.”

“All of the climate models under all representative concentration pathway (RCP) project that Colorado’s climate will warm substantially by 2050. Under RCP 4.5 (medium-low emissions scenario), Colorado’s annual temperatures are projected to warm by +2.5°F to +5°F by mid-century relative to 1971–2000 observed baseline. Under RCP 8.5 (high emissions scenario), Colorado’s annual temperatures are projected to warm by +3.5°F to +6.5°F by mid-century. Summers are projected to warm slightly more than winters under both RCPs. Looking beyond the 2050-centered analysis period, the warming trend is projected to continue into the late-21st century under all RCPs except RCP 2.6. By the period centered on 2070 (2055–2084), the projected warming in Colorado annual temperatures under RCP 4.5 is +2.5°F to +6.5°F relative to the 1971–2000 baseline. Under RCP 8.5, the projected warming is +5.5°F to +9.5°F relative to the 1971–2000 baseline.” [Lukas *et al.* 2014 page 61]

An analysis of projected 21st century temperature trends as a function of elevation in the Northern Hemisphere mid-latitudes from CMIP5 models shows more warming at higher

elevations during winter, particularly in the daily minimum temperature (Rangwala *et al.* 2013 [cited in Lukas *et al.* 2014 page 63]). “However, as discussed in Section 3, the global climate models do not represent the topography of Colorado very well, so it is difficult to discern whether the warming projected for the higher elevation regions (>10,000’) in the state is substantially different from that projected for lower elevations” (Lukas *et al.* 2014 page 63).

On average, the climate models indicate a seasonal shift in precipitation for Colorado, with increasing winter precipitation, and in some areas a decrease in late spring precipitation (Lukas *et al.* 2014, page 65).

Vegetation Management - In the past decade, vegetation management within lynx habitat has been predominantly salvage of dead and dying timber caused by a mountain pine beetle infestation in the northern part of the state (generally north of Interstate 70), and a spruce bark beetle infestation south of the interstate. Salvage operations may temporarily impact understory regeneration, if present, reducing the capacity of the stand to support higher snowshoe hare densities. Assuming the existing US Forest Service plans retain their current conservation framework, USFS lands should continue to provide sufficient habitat for lynx through the end of the century.

Vegetation management on non-federal ownerships within lynx habitat is unlikely to cause significant concern for lynx conservation in Colorado through the remainder of the century.

Wildland Fire Management - “It is generally acknowledged that in the Southern Rocky Mountains fire suppression has altered historic vegetative patterns. This effect has been most pronounced within vegetation communities where fire regimes are of low intensity or mixed severity. It is generally agreed that spruce-fir habitats have been little affected by fire suppression because the fire regimes within this type tend to be stand-replacing events occurring at long intervals (100+ years). Depending on the moisture regime, large stand-replacing fires within lynx habitat may produce young age class snowshoe hare habitat after approximately 10-30 years. Although this vegetative condition may provide some high quality snowshoe hare habitat, mature forests are also very important as winter foraging habitat.” (USFS 2008 page 36)

Habitat Fragmentation - Sources of current habitat fragmentation include high-speed high-volume highways, high mountain valley developments, vegetation management, ski/recreation area development, and wildland fire. Currently, only vegetation management on USFS lands is managed to limit lynx habitat fragmentation. Highways are likely to be expanded to accommodate increasing traffic volume as mountain valley communities continue to be developed and expended. While these linear features already exist on the landscape, widening of the cleared right-of-way, as well as behavioral avoidance of highway rights-of-way due to traffic reduces available habitat. Many ski areas in Colorado are located within lynx habitat and will likely be expanded in the future through permanent removal of vegetation to create conventional ski runs, reducing tree density and clearing understory vegetation to create glade conditions, reduces lynx habitat. The magnitude of fragmentation caused by these sources of

has not been quantified, but is unlikely to remove enough habitat to eliminate the possibility of lynx persistence in Colorado.

Chapter 6: Synthesis

This section synthesizes the needs, current condition, and likely future condition of the Canada lynx in the contiguous U.S. DPS with respect to the conservation biology principles of representation, redundancy, and resiliency. Its purpose is to provide an understanding of the range-wide status of this DPS that is as clear as possible given the unavoidable uncertainties involving demography and long-term threats.

Needs

Throughout the species' range, the lynx is a habitat and prey specialist requiring boreal forests with dense horizontal cover, long winters, and deep, fluffy snow, which gives it a competitive advantage for exploiting its primary prey, the snowshoe hare. Lynx in the contiguous U.S. have ecological requirements similar to those of lynx in Canada and Alaska, and throughout the species' range hare abundance is the primary driver of lynx population dynamics. However, the DPS is at the southernmost margin of the species' range, where boreal forests transition to temperate conifer and hardwood forests, and where snow conditions and hare abundance generally become less favorable with decreasing latitude. Because of this, habitat is less extensive and generally more fragmented within the DPS range than in the core of the species' range in Canada and Alaska. As a result, lynx in the contiguous U.S. are naturally less abundant and more patchily distributed than in the core of the range. Maintaining connectivity between lynx populations in Canada and the DPS is thought to be important; however, whether and if so to what extent the demographic and/or genetic health of DPS populations relies on periodic immigration from Canadian populations remains uncertain.

Current Conditions and Threats

Resiliency, the ability to withstand stochastic disturbance events, and redundancy, the ability to withstand catastrophic events, are currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. Available information indicates that five out of six geographic units in the DPS contain resident breeding lynx populations. Although we have no reliable population-size estimates for any of the geographic units, Northern Maine (Unit 1) is believed to currently support the largest resident population in the DPS. In Northeastern Minnesota (Unit 2), a resident population occupies the Arrowhead Region of the State. Northwestern Montana and northeastern Idaho (Unit 3) continue to support resident lynx, although a small subpopulation in the Garnet Mountains on the southern periphery of this unit may have been extirpated recently. In North-central Washington (Unit 4), recent extensive wildfires have temporarily reduced the amount of high-quality lynx habitat and may have caused a decline in lynx numbers there. Since the release of Canadian and Alaskan lynx in 1999-2006, resident lynx currently occupy western Colorado (Unit 6). The Greater Yellowstone Area (GYA, Unit 5) is thought to have historically supported a small

resident population; however, resident lynx have not been documented recently in this unit. The apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distr bution and relative abundance of resident lynx are substantially reduced from historic conditions suggest the historical and recent resiliency of lynx populations in the DPS. The large sizes and broad geographic distributions of the areas occupied by resident lynx populations likewise indicate adequate historical and current redundancy in the DPS to preclude its extirpation because of catastrophic events.

Representation, the ability of a species to adapt to changing environmental conditions over time, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Information provided by lynx experts and geneticists indicates high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Hybridization with bobcats has been documented but is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Thus, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions.

The primary threat identified at the time of listing, lack of regulations protecting lynx habitat on federal lands, has been largely addressed by formal and binding amendments or revisions to most federal land management plans within the DPS range. Although questions remain about the efficacy of this improved regulatory framework, federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands. Most federal lands, which constitute 64 percent of lynx habitat evaluated in this SSA, are found in the western U.S.

Other stressors affect lynx in one or more geographic units. For example, in northern Maine, where most high-quality lynx habitat occurs on private commercial timber lands and is the result of past timber harvest, changes in State forestry regulations (the Maine Forest Practices Act of 1989) that govern private forest management may currently be causing decreases in habitat quantity, quality, and distribution, and in lynx numbers (also see *Future Conditions and Threats*, below). The lack of binding lynx conservation commitments on private lands may exacerbate this risk to current lynx habitats in Maine. In North-central Washington, recent large-scale wildfires have resulted in the temporary loss of nearly 50 percent of lynx habitat, likely reducing this unit's current lynx population and potentially compromising its current ability to support a

resident population until habitats recover. Increased wildfire activity also has impacted lynx habitats in the other western geographic units (Northwestern Montana/Northeastern Idaho, the GYA, and Western Colorado), but the extent to which it has influenced the current condition of lynx populations in those units is uncertain.

Climate change is occurring at a global and, thus, a DPS-wide scale. Climate warming has reduced snow amount, duration, and quality (in terms of conditions favorable for lynx), it has been linked to increased frequency, size, and severity of wildfires and forest insect outbreaks, and it likely has already resulted in some changes in forest vegetative communities. Climate warming has also been linked to changes in the amplitude, periodicity, and synchronicity of northern hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in the DPS depend on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and an increased likelihood of extirpation among resident populations would be expected. However, whether, and if so to what extent, these climate-mediated factors have influenced current lynx numbers, other demographic parameters, and/or habitat quality and distribution is uncertain and has not been quantified across the range of the DPS or in individual geographic units. Despite uncertainty regarding its influence over current conditions for lynx, climate modeling and expert opinion concur that continued climate warming will adversely impact lynx in the DPS in the future (see below).

Future Conditions and Threats

Overall, expert opinion and our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). Forest management on private lands that lack lynx conservation commitments may also contribute to future declines, particularly in northern Maine. In each geographic unit, the probability that resident lynx populations will persist is expected to decline. The loss of resident lynx from one or more geographic unit would represent reduced future resiliency, redundancy, and representation within the lynx DPS.

The resiliency of lynx populations in individual geographic units is the primary determinant of the future viability of the lynx DPS. Expert opinion and our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing,

extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are l kely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible to stochastic events.

The loss of any geographic units would also reduce the level of redundancy and could diminish representation within the DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation of one or more of the individual geographic units (e.g., fires in north-central Washington, as described above), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and l kely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Furthermore, based on expert input, there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS. How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and l kely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Given the high percentage of federal land ownership in the West, regulatory commitments that these lands will continue to be managed in accordance with lynx conservation principles, and

the existence of potential high-elevation climate refugia to which lynx habitats and some lynx might move, the western geographic units (Units 3-6) may be more l kely to support resident lynx longer under projected continued climate warming. Nonetheless, it is unlikely that any management actions can abate the long-term retreat of boreal forests and diminished snow conditions projected by climate models. Further, the size, frequency, and intensity of wildfires and forest insect outbreaks are expected to increase with continued climate warming, particularly in the western portion of the DPS, although we do not anticipate such events in-and-of-themselves are likely to cause the permanent loss of breeding lynx populations in any geographic unit.

Although projections of climate-mediated losses of boreal forests and favorable snow conditions suggest impacts to lynx and hare populations throughout the DPS, persistence of resident lynx in Maine and Minnesota may be relatively lower than the western geographic units given the smaller percent of federal lands and the absence of associated regulatory commitments to lynx conservation, and the lack of potential elevational refugia. Additionally, as noted above, changes to regulations governing timber harvest on private forest lands in Maine are unlikely to maintain the current historically-high amount and distribution of good lynx habitat or the current large population of resident lynx. These changes, which may affect over 90 percent of lynx habitats in northern Maine, are projected to result in substantial declines in habitat quality and distribution, and lynx numbers, over the next 10-30 years, primarily through restrictions on clearcutting and the proliferation of partial harvesting, which are detrimental to snowshoe hare and lynx needs. On private forest lands, energy development (wind energy, mining), rapid turnover in ownership and parcelization of forest land, and uncertain forest markets may also reduce the future quality and quantity of lynx habitat.

DPS viability

Although all five geographic units that currently support populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more l kely than not) by the end of the century (Lynx SSA Team 2016, pp. 36-49, 58). All other geographic units have a 50 percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century, with a moderate to high likelihood that resident lynx will be lost from two to four units by then. Potential elevational refugia may increase the likelihood of persistence in western units, although uncertainty remains about the timing of warming-driven upslope movements of habitats and snow conditions and the extent to which hare and lynx populations may follow them. Regardless, future lynx habitats throughout the DPS range are likely to be smaller and more fragmented, and geographic units that are already relatively isolated from other lynx populations are likely to become even more isolated in the future. Despite the lack of elevational refugia, lynx may also persist at the end of the century in Maine and Minnesota, depending on the timing and severity of climate change effects and, in Maine, on trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in

concert with input from lynx experts suggests that the probability of the persistence of resident breeding populations will decline in all geographic units beginning as early as 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the potential functional extirpation of resident lynx populations from one or more geographic unit would demonstrate a loss of resiliency, reduced redundancy, and, possibly, reduced representation within the DPS. These losses in resiliency, redundancy, and representation will put the Canada lynx DPS at increasing risk of extirpation through the end of this century.

From:	Miller, Martin
To:	Hecht, Anne
Subject:	Re: sending the Lynx SSA?? --
Date:	Thursday, October 20, 2016 5:10:56 PM
Attachments:	2016 10 14 DRAFT Lynx SSA Report CLEAN_MJMcomments.docx

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Sorry this is late. Reading just the Executive Summary and my comments on it should give you an idea of my concerns about what we get out of the SSA process in the end.

On Thu, Oct 20, 2016 at 9:03 AM, Hecht, Anne <anne_hecht@fws.gov> wrote:

> Hoping to print the executive summary before I leave today.
>
> **********
> Anne Hecht, Endangered Species Biologist
> U.S. Fish and Wildlife Service
> 73 Weir Hill Road
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> email: anne_hecht@fws.gov

--
Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

Species Status Assessment

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment



Photo by Keith Williams

Version 2.0 - Draft
~~September~~ October 2016

U.S. Fish and Wildlife Service
Regions 1, 3, 5 and 6

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Executive Summary

Background

This report presents the results of a species status assessment (SSA) conducted for the contiguous United States distinct population segment (DPS) of Canada lynx (*Lynx canadensis*). The DPS was listed in 2000 as threatened under the Endangered Species Act (ESA) because of the inadequacy of regulatory mechanisms on federal lands. The SSA will provide the scientific basis for the statutorily required 5-year status review for this listed species and other decisions the Service is required to make in accordance with the ESA. The SSA provides an evaluation of the current and future status of lynx in six geographic units within the DPS that currently support or recently supported resident breeding populations. The units are distr buted across the northern contiguous U.S. from Maine to Washington and south along the Rocky Mountains to western Colorado. These geographic units combined represent approximately the southern two percent of the species' entire breeding range (ninety-eight percent occurs in Canada and Alaska). The units are relatively isolated from each other, although four of the six units are directly connected to lynx populations and habitats in Canada. These SSA geographic units are:

Unit No.	Name	Size (km^2)
Unit 1	Northern Maine	28,909
Unit 2	Northeastern Minnesota	21,101
Unit 3	Northwestern Montana/Northeastern Idaho	26,997
Unit 4	North-central Washington	5,176
Unit 5	Greater Yellowstone Area	23,687
Unit 6	Western Colorado	25,294

The SSA relied on both the available scientific literature and the professional judgments and opinions of recognized lynx experts to (1) describe the ecological requirements and population dynamics of the species, (2) evaluate the historical and current status of lynx populations in the six geographic units and the factors that appear to have influenced these populations, and (3) assess the likely future viability of the DPS through the end of the century in terms of representation, redundancy, and resiliency (the "3 Rs").

Commented [MJM1]: The document sometimes uses historic and sometimes historical. Recommend being consistent. "Historical" avoids confusion with the "momentous" meaning of "historic."

Commented [MJM2]: The purpose of the SSA should be to assess the full risk profile of the species. The viability of the species should be a description of the risk to its persistence, which may be influenced by possible future scenarios that are less than likely.

Lynx are habitat and prey specialists and require boreal forests having long winters with deep, fluffy snow. These conditions provide lynx with a competitive advantage over other predators for exploiting their primary prey, the snowshoe hare. Lynx habitat and, thus, lynx are naturally less abundant and more patchily distributed in the DPS than in the core of the species' range in Canada and Alaska. This is because the DPS occurs at the southernmost margin of the

species' range and of the environmental thresholds of snow quality, depth, and persistence; hare density; and boreal forest conditions that lynx require. Maintaining connectivity between the DPS and lynx populations in Canada is thought to be important, but whether DPS populations rely on intermittent immigration of lynx from Canada, and, if so, to what extent, remain uncertain.

Research and surveys undertaken since the listing of the DPS in 2000 have significantly improved our knowledge of the distribution, habitats, and population status of resident breeding lynx populations. For example, although we knew there were resident lynx in Maine, we did not have an understanding of population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS; we also understand that past timber management has created the current abundance of high-quality lynx habitat, and we believe that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain as to whether Minnesota supported a resident breeding population, but we now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. are naturally less abundant and more patchily distributed than was thought at the time of listing, and lynx may have been recently extirpated from several areas thought to have previously supported small resident populations (the Kettle Mountains in northeastern Washington, the Garnet Mountains in western Montana, and the Greater Yellowstone Area). We also know that recent extensive wildfires in north-central Washington have temporarily reduced the amount of high-quality lynx habitat and have probably caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999 to 2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado.

Commented [MJM3]: To distinguish from regulatory status as E or T.

SSA Framework

The framework for conducting an SSA takes into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time. Relative to the ecological requirements of the lynx within the DPS, we assessed current conditions at the individual, population, and range-wide levels, and the likely changes in the environment that may influence the future condition of individuals, populations, and the DPS and thus the viability of the DPS.

Commented [MJM4]: I hope the risks of less-than-likely changes to the environment were also assessed.

The SSA uses the conservation biology principles of representation, redundancy, and resiliency (the "3 Rs") as the framework for assessing current and future conditions. Resiliency describes the ability of the species to withstand stochasticity, redundancy describes the ability of the species to withstand catastrophic events, and representation descr bes the ability of the species to adapt over time to long-term changes in the environment. The 3 Rs can be influenced by any number of factors. For the lynx, these factors included the original reason for listing the lynx DPS as threatened: inadequacy of regulatory mechanisms. Other factors included climate change, vegetation management, wildfires, and habitat connectivity

SSA Assumptions and Uncertainties

A fundamental hypothesis underlying the SSA is that the ability of lynx to persist in the DPS is a function of metapopulation dynamics with Canada, i.e., the DPS is infused intermittently with lynx from Canada following high hare cycles.

Overall, uncertainties abound with regard to lynx demography and effects of various stressors on DPS populations. The primary sources of uncertainty for this analysis include a lack of empirical data regarding population sizes and trends, the extent of immigration of lynx from Canada ~~to the persistence of U. S. populations~~, trends in hare populations, and effects of habitat management on lynx. Most importantly given the importance of climate change as a stressor, we lack information on the pace and extent of changes in snow quality, depth, and persistence and how ~~this~~these changes affect~~s~~ the relationship between lynx and their competitors.

For purposes of the SSA, we forecasted potential effects and trends through the end of this century. This time frame is based on the level of uncertainty about climate change and other effects on lynx populations; it is also a long enough time frame to detect lynx population trends across the DPS.

Current Conditions

Currently, ~~four~~ of the six DPS units, four (Northern Maine, Minnesota, Northwestern Montana, and Western Colorado) demonstrate high levels of resiliency. The North-central Washington Unit (Unit 4) was also considered resilient until recent wildfires consumed an extensive amount of habitat, likely resulting in a diminished population that may be susceptible to stochastic events. The Greater Yellowstone area historically supported resident lynx, but it is unclear whether the area still supports a breeding population due to the distance and relative isolation of the unit from Canada as well as the less than favorable habitat conditions and snowshoe hare densities.

As shown in the table above, five of the six units are larger than 20,000 km^2; the other is over 5,000 km^2. Land ownership within the units varies from mostly private in Maine, to a mix of private, State, and fFederal lands in Minnesota, to mostly fFederal lands in the West. Overall, fFederal lands account for nearly 64 percent of the areas encompassed by the SSA units. Of non-fFederal areas, private lands make up almost 27 percent of the total followed by State and Tr bal lands. Available data indicate that distribution within the DPS remains similar to historical patterns and that the number of units across the DPS has not been meaningfully diminished from historical levels, given the uncertainty about the past occupancy of the Greater Yellowstone area by a resident breeding lynx population.

Given the resiliency of most geographic units and the ~~improbability~~ low likelihood that a~~ny imminent~~ catastrophic event will cause the extirpation of an entire unit or, especially, the DPS as a whole in the immediate future, redundancy is not currently a~~t~~n issue for the lynx DPS. Also,

Commented [MJM5]: This doesn't make sense in this phrase.

Commented [MJM6]: This is inconsistently referred to as Northwestern Montana and Northwestern Montana/Northeastern Idaho. Recommend being consistent.

Commented [MJM7]: Resiliency relates to the ability to withstand stochasticity. How is it a factor in drawing this conclusion about redundancy?

Commented [MJM8]: This seems to be saying we know of at least one catastrophic event that will happen soon but won't cause extirpation. This is at odds with our definition of a catastrophic event as an event that would or has high potential to cause extirpation. Because the kinds of catastrophic events we typically deal with are unpredictable, we can't say a catastrophic event is imminent unless it's already started. A catastrophic event has a low likelihood of occurring within a short period of time and a higher likelihood over a longer period of time. I think what we're trying to say is simply that a catastrophic event is not likely to happen in the near term.

Commented [MJM9]: I was confused by this wording. We're in the business of assessing risk over decades into the future, so a factor that affects that long-term risk would be an issue for us to evaluate now and therefore would be currently an issue. I think what we're trying to say is that it is "not an issue for the near-term persistence of the DPS."

because lynx are genetically similar throughout the entire range of the species, and because we did not find any diminishment of adaptability and evolutionary capacity of DPS populations based on the known historical record, we do not consider representation to be a current issue for lynx.

The original reason for which the DPS was listed, inadequacy of regulatory mechanisms, has been largely ameliorated on public lands within the western geographic units. Climate change, vegetation management, wildfires, and habitat fragmentation are now stressors of more heightened concern. We know that wildfires are causing depletion of lynx in some areas in the West, particularly in the North-~~C~~central Washington Unit. We also know that past vegetation management in the ~~n~~Northern Maine Unit has resulted in a lynx population that is currently the largest in the DPS. Conversely, stressors such as climate change and associated habitat alterations, while currently occurring, may not demonstrate demographic effects on lynx within the next decade.

Future Conditions

Resiliency of individual geographic units, which function independently of each other, is the primary determinant of future lynx DPS viability. Overall, our analysis indicates a ~~reduced~~decreasing probability of persistence for ~~all~~each geographic unit~~s~~ within the DPS over the rest of the century (noting that the analysis did not extend beyond that 2100 time frame). It further indicates a consequent permanent loss of two to four of the six units, i.e., loss of resiliency, by the end of the century.

Representation and redundancy are lesser factors for DPS viability~~,~~ for several reasons. Although the populations in the DPS units are demographically isolated from each other, there is little risk of significant genetic drift within the DPS, likely due to most areas being relatively well connected with Canadian populations; this is indicative of relative genetic health through the end of the century. Furthermore, based on expert input, there is no indication that the relatively low level of genetic diversity is likely to reduce DPS viability in the future (USFWS 2016, p. 51). Because of the ability of lynx to widely disperse, and because it is unlikely that insurmountable barriers to lynx dispersal between Canada and the DPS will emerge, we do not expect representation to become a concern through the turn of the century.

With regard to redundancy, neither the scientific literature nor expert input provide a basis for concluding that any catastrophic event could cause extirpation of any one geographic unit. It is even less likely that a single catastrophic event will eliminate all populations in the DPS. It is important to note, however, that a sequence of less-than-catastrophic events could result in extirpat~~e~~ion of one or more ~~individual~~ units over time, thereby reducing redundancy within the DPS.

The likelihood of persistence of individual populations, and thus geographic units, is expected to decrease by 2100 primarily because of climate change effects on snow conditions and boreal forests. The other long-term threat is forest management practices that are not conducive to

Commented [MJM10]: See comment above.

Commented [MJM11]: By itself, this sounds like a good thing. Explain how this is a "heightened concern."

Commented [MJM12]: Is this the timeframe that defines current condition? If not, say instead something like "may not cause demographic effects for a decade or more."

Commented [MJM13]: Reduced from what?

This is a meaningless statement. Every species has a decreasing probability of persistence with increasing time. Describe the decrease in terms of its magnitude and/or significance.

Commented [MJM14]: Is this change correct? Or are you trying to say one or more units have increasing probabilities but the DPS as a whole has a decreasing probability?

Commented [MJM15]: Wouldn't loss of populations be a loss of redundancy, not resiliency? The loss of populations is a loss of redundancy; the means by which these populations are lost is the decrease in resilience over time.

Commented [MJM16]: I assume this is based on the "most likely" future scenario. What is the risk of loss of more than two to four units? We need to know the full risk profile.

Commented [MJM17]: But is there a meaningful risk?

Commented [MJM18]: But is there a meaningful risk?

Commented [MJM19]: "Could" is ambiguous. Would be better to say there is "no meaningful risk" of a catastrophic event causing extirpation of any one unit.

Commented [MJM20]: The odds of all of several events happening is always less than the odds of any single event happening. Describe this risk in more absolute terms rather than in terms of a meaningless comparison.

Commented [MJM21]: I thought this was referring to a sequence of catastrophic events, each one causing extirpation of a unit. Made this change to avoid that interpretation.

Commented [MJM22]: Isn't this statement saying the same thing as the last sentence in the first paragraph of this section? This sentence says the loss of populations "could" occur; the sentence in the first paragraph describes this as predicted to happen. Recommend being more precise.

Commented [MJM23]: This is a meaningless statement. Every species has a decreasing likelihood of persistence over time. What we're talking about here is our prediction of a decrease of a certain magnitude that is due to certain factors. Recast the sentence to something like "The predicted decrease in the likelihood of persistence of individual populations, and thus geographic units, over time is driven primarily by climate change effects ."

landscape hare densities able to support lynx, although this stressor may be limited to one geographic unit. Threats affecting the future condition of the DPS are summarized below.

Based on climate change models, the effects of climate change on snow and boreal forest conditions are foreseen as the primary stressor limiting future viability of lynx in the DPS. The southernmost boreal habitats are predicted to retreat northward and upslope, fragmenting and diminishing the quality of lynx and hare habitat within the DPS (although some uncertainty remains regarding the timing, extent, and biological consequences of such impacts). As habitat conditions decline, mortality rates are likely to increase and reproductive rates decrease. This in turn will reduce abundance and density of individuals within populations, making lynx populations more suscept ble to stochastic events.

Given the percent of ~~f~~Federal land ownership, -regulatory assurances that these lands will be managed in accordance with lynx conservation, and a stronger possibility that lynx populations will be able to relocate to higher elevations, western geographic units are more likely to support lynx longer than other units under projected climate change scenarios. Nonetheless, we are unaware of any management action that can abate the long-term retreat of boreal forests and changed snow conditions. Further, climate-induced frequency and intensity of wildfires and disease events ~~is~~are expected to increase, particularly in the western portion of the DPS, although we do not anticipate such events ~~in and of themselves~~ alone to cause the permanent loss of breeding lynx populations in the North~~west~~-central Washington Unit or any other unit.

With regard to the eastern geographic units (Minnesota and Maine), suitable boreal forest and snow conditions are projected to decline more severely than in the western units. Lynx habitat conditions in Maine are also likely to decline significantly by the end of the century as private forest management practices, particularly a decline in clearcutting, result in succession detrimental to snowshoe hare and lynx needs.

DPS viability

Although there is no evidence from the historical record that Canada lynx have declined within the DPS, a number of threats acting at the DPS and individual geographic unit scales indicate a moderate to high likelihood of declines (i.e., loss of two to four units) by the turn of the century. While it is more likely than not that any given individual unit—~~n~~Northern Maine, ~~n~~Northeastern Minnesota, ~~n~~Northwestern Montana, ~~w~~Western Colorado, and possibly ~~n~~North-central Washington—will persist to mid-century, it is unlikely all that five will persist to that point. By the end of the century, we expect populations to persist primarily in units having high-elevation refugia, e.g., northwestern Montana and possibly western Colorado, although Colorado would be an isolated unit. Lynx may also persist at the end of the century in Maine, depending on the severity of climate change effects and trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in concert with input from lynx experts indicates that all units will exhibit declines by 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

Commented [MJM24]: I can't tell what this is referring to. North-central Washington or Northwestern Montana.

Commented [MJM25]: This is good to know, but what I really want to know is the probability that all will not persist to that point – i e., the risk of extinction.

Commented [MJM26]: But what is the risk that they don't?

Commented [MJM27]: But what is the risk that they will not?

We conclude that the eventual loss of resiliency indicated by extirpation of geographic units will also reduce redundancy and, possibly, representation. These losses in resiliency, redundancy, and representation will put the Canada lynx U.S. DPS at increasing risk of extinction over the course of this century, and in all probability, the risk will continue to increase after that point.

Commented [MJM28]: This is a meaningless statement. All species are at increasing risk of extinction over time.

Chapter 1: Introduction

The U.S. Fish and Wildlife Service (Service) designated lynx in the contiguous U.S. as a distinct population segment (DPS) and listed it as threatened under the Endangered Species Act of 1973, as amended (ESA) in 2000 (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (U.S. District Court MT 2014b, p. 2). Thus, we conducted this SSA (version 1.0) to summarize the best available information on the current status and likely future viability of the DPS. This SSA will inform a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the ESA and (2) a recovery plan is needed to guide conservation and recovery of the lynx DPS.

1.1 Background

The Canada lynx is a North American wild cat that is most strongly associated with northern-latitude boreal forests (taiga) of Canada and Alaska (McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 373-374; Mowat *et al*. 2000, p. 272). It relies heavily on adequate populations of its primary prey, the snowshoe hare (*Lepus americanus*), to support survival, reproduction, recruitment, and, therefore, population persistence (Ruggiero *et al*. 2000a, p. 110; Mowat *et al*. 2000, p. 270; Steury and Murray 2004, pp. 128, 136-138; U.S. Fish and Wildlife Service 2005, p. 2; Interagency Lynx Biology Team [ILBT] 2013, pp. 30-34; 79 FR 54808-54809). Lynx survival and distribution is also influenced by snow conditions. It is generally restricted to areas that receive deep, powdery, and persistent snow that allows lynx, with their proportionately longer limbs and very large feet, to outcompete other terrestrial hare predators that are less efficient in such conditions (McCord and Cardoza 1982, pp. 748-749; Quinn and Parker 1987, p. 684; Buskirk *et al*. 2000a, pp. 89-94; Buskirk *et al*. 2000b, pp. 400-401; Ruggiero *et al*. 2000b, pp. 445–449; Hoving 2001, p. 75; Hoving *et al*. 2005, p. 744-749; Carroll 2007, entire; Gonzalez *et al*. 2007, entire; ILBT 2013, pp. 25-26; 79 FR 54809).

Lynx are generally considered secure, widespread, abundant, and distr buted throughout most of their historic ranges in Canada and Alaska, which, combined, account for roughly 98 percent of the species' distribution. Lynx are distributed across approximately 5.5 million km^2 (2.1 million mi^2) in Canada (Environment Canada 2014, p. 2) and 534,454 km^2 (206,354 mi^2) in Alaska (University of Alaska Center for Science Conservation 2016, entire; Reimer 2016, pers. comm.). The southern peripheries of the boreal forest and the distributions of snowshoe hares and lynx extend into the northern contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and

Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 379-382; Hodges 2000, pp. 163-173; McKelvey *et al*. 2000a, pp. 242-253), where the six geographic units evaluated in this SSA represent the remaining 2 percent of the species' breeding distribution (approximately 131,168 km^2 [50,644 mi^2]; see Figure 1 and Table 1, below). Lynx populations in the DPS seem to function as peripheral subpopulations (islands) of a larger (mainland) metapopulation centered in north-central Canada (McKelvey *et al*. 2000b, p. 25; 68 FR 40077; also see 2.2 below), and the demographic and genetic health and persistence of DPS populations are thought to be influenced by connectivity with, and immigration of lynx from, larger populations in Canada (McKelvey *et al.* 2000b, pp. 21, 33; Schwartz *et al.* 2002, entire; 78 FR 59434, 59447; 79 FR 54815).

Lynx were documented historically in 24 of the Lower 48 States (McKelvey *et al.* 2000a, pp. 207-232), but records in many places are associated with cyclic "irruptions" of large numbers of lynx dispersing from southern Canada when hare populations crashed; many of these occurrences were in anomalous habitats, and lynx were unable to persist and establish populations in most of these areas (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 242, 253; Aubry 2006, pp. 1-2; ILBT 2013, p. 23; see also section 2.3.2, below). Habitats capable of supporting persistent resident lynx populations in the contiguous U.S. occur over a much smaller geographic area that includes parts of the Northeast (primarily northern Maine), western Great Lakes (northeastern Minnesota), Rocky Mountains (northern Idaho, northwestern Montana; perhaps also parts of northeastern Washington, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming, and parts of western Colorado), and the eastern Cascade Mountains of northern Washington (68 FR 40077-40080; U.S. Fish and Wildlife Service 2005, p. 3; 79 FR 54806-54807; Lynx SSA Team 2016, pp. 6-7). Although uncertainty remains regarding the historic distribution of resident lynx in the contiguous U.S., and breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population decline in the contiguous U.S. has been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11; also see section 2.3.2, below).

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 14 states in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands (65 FR 16052). In 2003, in response to a court memorandum opinion on the 2000 listing rule, the Service reaffirmed its determination of the lynx DPS and its status as threatened under the ESA (68 FR 40076). The Service completed a recovery outline in 2005 (U.S. Fish and Wildlife Service 2005, entire), designated critical habitat for the DPS in 2006 (71 FR 66008) and, in 2007, again in response to a court order, clarified its determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS (72 FR 1186). Also in 2007, the Service initiated a 5-year status review of the DPS (72 FR 19549). The Service revised the critical habitat designation for the DPS in 2009 (74 FR 8616) and 2014 (79 FR 54782) and, concurrent with the latter, rescinded the state-based definition of the DPS boundary to formally extend ESA protection to lynx "where found" in the contiguous U.S., including New Mexico and other states that were not included in the original DPS range (79 FR 54804). The Service reinitiated the 5-year status review in 2015

(https://www.fws.gov/mountain - prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php), and that review will be informed by this SSA report. On September 7, 2016, the U.S. District Court for the District of Montana remanded the 2014 critical habitat designation to the Service for further consideration.

The six geographic units evaluated in this SSA encompass all areas of the contiguous U.S. that currently support or are believed to have recently supported persistent resident lynx populations (Figure 1). Five of the six geographic units were designated as "Core Areas" in the Recovery Outline (USFWS 2005, pp. 4-6, 21, 23), and western Colorado was designated a "Provisional Core Area" (USFWS 2005, pp. 6, 21, 23). With the exception of western Colorado, these units also encompass and closely mirror the areas the Service designated as critical habitat in 2014 (79 FR 54782). Some areas adjacent to but outside these geographic units are known or suspected to intermittently support lynx home ranges and occasional reproduction. Uncertainty remains as to whether resident lynx populations occurred historically in other areas not encompassed by the geographic units evaluated here.

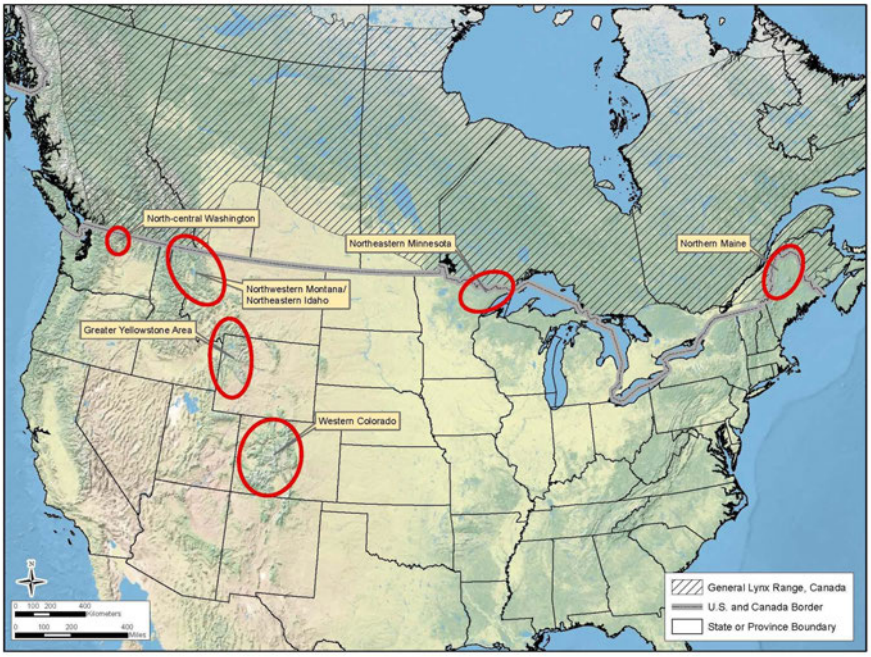


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*) that currently support or recently supported (GYA)

resident lynx populations relative to the general range of lynx in Canada. Range in Canada based on Poole (2003), Koen *et al.* (2014), and Vashon (2015).

The six geographic units include federal, private, State, and Tribal lands. The amounts in each ownership vary among the units, with private lands predominating in Maine, a mix of ownerships in Minnesota, and federal lands predominating in the western units (Table 1).

Table 1. Lynx SSA Unit Sizes and Percent Ownership.

Unit[1]	Unit Size (km^2)	Percent of SSA Area	Land Ownership/Management (Percent)[2]						
			Federal				Private	State	Tr bal
			All Federal	USFS	NPS	BLM			
1	28,909	22.0	0	0	0	0	91.6	7.3	0.9
2	21,101	16.1	47.4	44.9	2.5	0.01	15.5	36.2	1.0
3	26,997	20.6	84.3	69.3	13.6	1.5	8.0	4.1	3.5
4	5,176	3.9	91.5	84.6	6.7	0.1	0.3	8.2	0
5	23,687	18.1	97.6	79.7	16.7	1.1	2.2	0.3	0
6	25,294	19.3	90.1	85.2	1.8	3.1	9.3	0.6	0
All Units	131,164	100	63.6	55.6	6.8	1.1	26.5	8.8	1.1

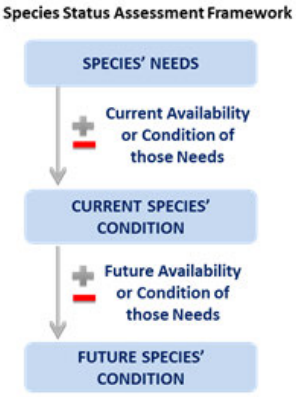
[1] Unit 1 - Northern Maine; Unit 2 - Northeastern Minnesota, Unit 3 - Northwestern Montana/ Northeastern Idaho, Unit 4 - North-central Washington, Unit 5 - the Greater Yellowstone Area (southwestern Montana/Northwestern Wyoming), Unit 6 - Western Colorado.

[2] Unit sizes and ownership for units 1-5 are those calculated for the areas designated in 2014 as lynx critical habitat, including some Tribal, State and private lands that met the criteria for critical habitat but which were excluded from the designation in accordance with section 4(b)(2) of the Endangered Species Act. Unit 6 size and ownership were calculated by the Service's Western Colorado Field Office in coordination with Colorado Parks and Wildlife based on telemetry data from radio-marked lynx.

1.2 SSA Framework and Report

The Service is engaged in a number of efforts to improve the implementation of the ESA (see http://www.fws.gov/endangered/improving_ESA/). As part of this effort, our Endangered Species Program has developed the Species Status Assessment (SSA) Framework to guide how we assess the best scientific and commercial data available when evaluating the biological status of species. In conducting an SSA, we take into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time (captured under the broad heading of "species needs"); the current condition of the species at the

individual, population, and range-wide levels in terms of meeting those needs; and the likely changes in the environment that may influence the species' future condition and, thus, the viability of the species.



The SSA Framework defines viability as a description of the ability of a species to sustain populations in the wild beyond a biologically meaningful time frame[1]. Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3 Rs") as a lens to evaluate the current and future condition of the species. Briefly, resiliency describes the ability of the species to withstand stochastic events; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. As a result, the SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings. Importantly, the SSA neither results in, nor predetermines, any decisions by the Service under the ESA.

The Species Status Assessment Report (SSA Report) is a summary of the information assembled, reviewed, and assessed by the Service and is based on the best scientific and commercial data available at the time of the assessment. Completed SSA Reports and supporting material can be found at the collaborative repository of the National Park Service and the USFWS called "ServCat" at the following IP address: *http://www.fws.gov/Refuges/NaturalResourcePC/landM/serviceCatalog.html*.

1.3 Analytical Approach/Methods

We used the SSA Framework (October 2015, version 3.3) described above to evaluate the current status of resident lynx in the contiguous U.S. as well as the likelihood that the geographic areas supporting resident lynx in the DPS would continue to do so in the near term and at mid- and end-of-century (years 2025, 2050, and 2100). We framed our evaluation in terms of the 3 Rs using conceptual modeling (Figure 2) based on available published literature, other information on the historic and current status of and threats to lynx in the DPS and, where empirical data are lacking, on formally-elicited expert opinion and best professional judgment (Lynx SSA Team 2016, entire).

[1] Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations in the wild over time. USFWS. 2015. Species Status Assessment Framework. Version 3.3. October 2015.

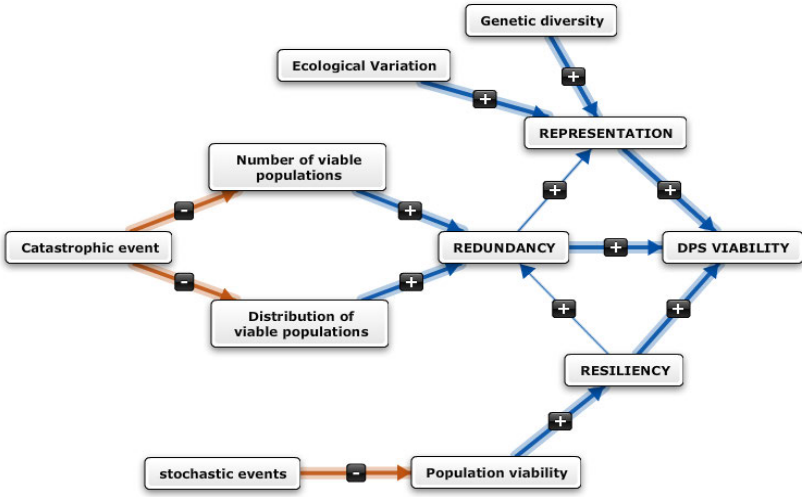


Figure 2. Conceptual model of the factors thought to influence the 3 Rs as they pertain to lynx viability.

We applied the definitions from the SSA Framework for the principles of redundancy, representation, and resiliency, provided in section 1.2, to Canada lynx as described below. We evaluated redundancy and representation at the scale of the DPS as a whole, and resiliency at the scale of lynx populations within each of the six geographic units.

To evaluate **redundancy** for the lynx DPS, we considered the current and likely future geographic distributions of resident breeding populations and whether the DPS is currently vulnerable to extirpation due to catastrophic event or would be in the future. Figure 3 shows examples of relationships among factors that may influence redundancy within the lynx DPS.

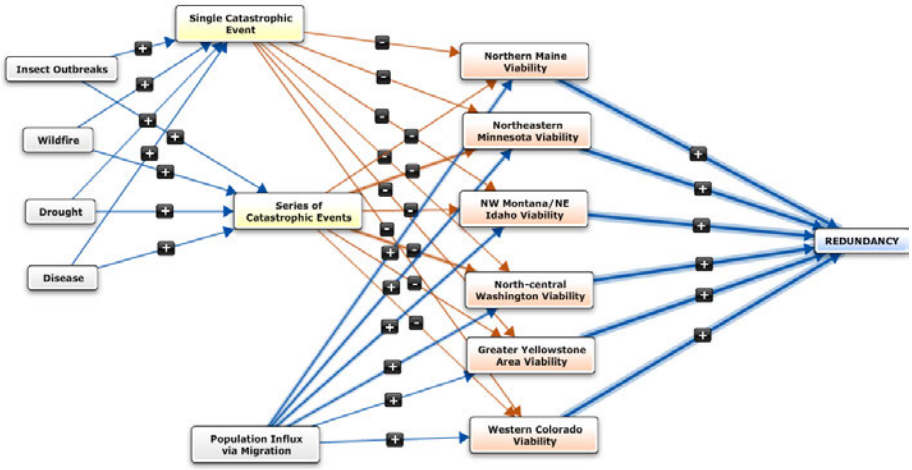


Figure 3. Conceptual model of factors thought to influence redundancy within the lynx DPS.

To evaluate **representation** for the lynx DPS, we considered measures of genetic diversity and heterozygosity, the current and likely future ecological diversity of geographic areas occupied by resident breeding populations, and the documented dispersal capabilities of the species, as shown in Figure 4 below.

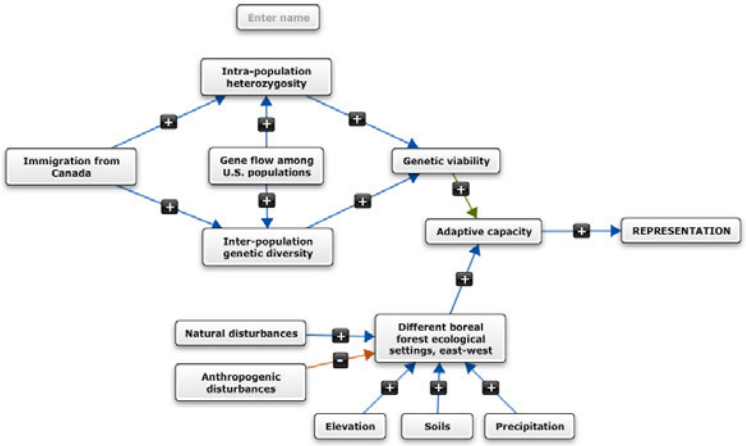


Figure 4. Conceptual model of factors thought to influence representation within the lynx DPS.

Because we lack reliable estimates of population sizes and trends, growth rates, and other long-term demographic data for most populations in the DPS, our evaluation of the **resiliency** of lynx

populations in the DPS was based largely on consideration of recent status updates and formally-elicited expert opinion regarding the likelihood that DPS populations will remain viable into the future. The relationships among factors that influence DPS resiliency are shown in Figure 5 below.

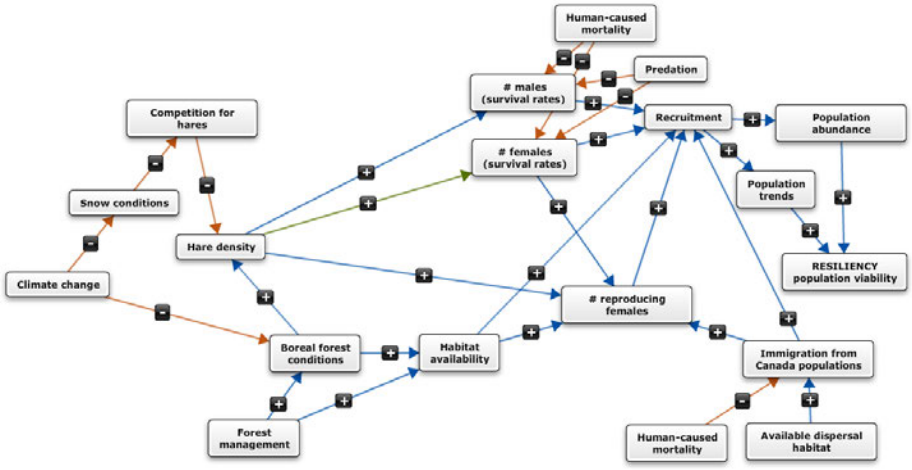


Figure 5. Conceptual model of factors thought to influence the resiliency of lynx populations within the DPS.

Chapter 2: Lynx Ecology

In this chapter, we describe the physical characteristics, taxonomy, and genetics of the Canada lynx, its life history and population dynamics, and its taxon-wide and DPS distributions. We rely heavily on recent summaries of this information provided in the revised *Canada Lynx Conservation Assessment and Strategy* (LCAS; ILBT 2013, entire), the Service's recent proposed (2013) and final (2014) rules to revise the designation of critical habitat for the DPS (78 FR 59430-59474; 79 FR 54782-54846), and the results of an October 2015 lynx expert elicitation workshop (Lynx SSA Team 2016, entire). We also provide a summary of the pertinent ecological requirements of lynx at the individual, population, and DPS levels. These ecological requirements form the basis of our analyses conducted in Chapters 3 through 5.

2.1 Species Taxonomy, Description, and Genetics

The Canada lynx (order Carnivora; family Felidae) is one of four species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). There are

three recognized subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. mollipilosus* ("Arctic lynx," Stone 1900), and *L. c. subsolanus* ("Newfoundland lynx," Bangs 1897) (Integrated Taxonomic Information System online database, http://www.itis.gov, retrieved April 14, 2016).

The Canada lynx is a medium-sized cat with long legs and large, well-furred paws. In winter, the lynx's fur is dense and has a grizzled appearance with a grayish-brown mix of buff or pale brown fur on the back, and a grayish-white or buff-white fur on the belly, legs, and feet. In summer, its fur is more reddish to gray-brown (McCord and Cardoza 1982, p. 730). It has long tufts of black hairs extending from the tips of its ears, a short, completely black-tipped tail, and often a distinct dish-like facial ruff of pale hairs tipped black. Lynx generally measure 75 to 90 cm (30 to 35 in) long and weigh 6 to 14 kg (14 to 31 lb) (Quinn and Parker 1987, Table 1; Moen *et al.* 2010a, Figure 2; Maine Department of Inland Fisheries and Wildlife 2012, unpublished data), and males are 13-25 percent larger than females (Mowat *et al.* 2000, p. 267). The lynx's large feet and long legs make it highly adapted for traversing and hunting in deep, powdery snow, where its low foot-loading (weight per surface area of foot) is thought to provide a competitive advantage (Buskirk *et al.* 2000a, p. 90; 2000b, p. 400; ILBT 2013, pp. 26, 36, 81) over other terrestrial predators of snowshoe hares, the lynx's primary prey. In southern Canada and the northern contiguous U.S, where the southern edge of the lynx range overlaps the northern edge of the bobcat range, the two species are easily confused because of their similar size and appearance. However, the lynx's longer ear-tufts, larger feet, and black-tipped tail distinguish it from the bobcat, which has shorter ear tufts, small feet, white on the underside of the tail, and is much more common and abundant than lynx in most of the contiguous U.S..

Overall, genetics research suggests high gene flow across most of the continental range of lynx, l kely because of high dispersal rates, large dispersal distances, and the absence of significant barriers to genetic interchange throughout much of the lynx range, including the DPS (Schwartz *in* Lynx SSA Team 2016, pp. 11-12). Genetic evidence also indicates interactions between lynx populations even where physical barriers appear most likely to restrict gene flow. For example, although *L. c. subsolanus* on Newfoundland Island is genetically (Row *et al.* 2012, pp. 1262-1266; Koen *et al.* 2015, p. 528) and morphologically (Khidas *et al.* 2013, pp. 597-601) distinct from mainland lynx, there is evidence of genetic exchange between the two areas, indicating that some lynx are able to cross the 15-60 km-wide (9-37 mi) Strait of Belle Isle that separates them (Koen *et al.* 2015, p. 527). Similarly, despite some differences in functional genetic markers (unique alleles) in lynx south versus north of the St. Lawrence Seaway/River in eastern Canada, which suggest the potential for evolutionarily significant differences in those areas, recent analyses reveal genetic exchange among lynx on either side, indicating that some lynx successfully navigate this barrier (Koen *et al.* 2015, pp. 524-528; Bowman *in* Lynx SSA Team 2016, p. 12-13).

Schwartz *et al.* (2003, entire) documented reduced genetic variation (lower mean number of alleles per population and lower expected heterozygosity) among peripheral lynx populations compared to populations in the core of the lynx geographical range in Canada and Alaska. While recognizing that small changes in genetic variation can lead to large changes in

population fitness, the authors noted that the differences between core and peripheral populations in their study were small enough to suggest a lack of significant population subdivision (i.e., no indication of genetic isolation, substantial genetic drift, or potential genetic ‘‘bottlenecks’’ among DPS populations; Schwartz *et al.* 2003, p. 1814; 79 FR 54793). This finding is consistent with their earlier work, which documented high levels of gene flow (the highest yet documented for any carnivore) between core and peripheral lynx populations despite large separation distances (Schwartz *et al.* 2002, entire). Their results did not suggest that reduced genetic variation among peripheral populations was because of human disturbance (i.e., habitat loss/ fragmentation on the southern periphery of the geographic range; Schwartz *et al.* 2003, p. 1814), but they did imply that the persistence of lynx populations in the contiguous U.S. depends on dispersal from larger (core) populations (Schwartz *et al.* 2002, p. 522). Currently, there is no indication that the levels of connectivity and gene flow between lynx populations in the DPS and those in the core of the lynx’s range are inadequate to maintain the genetic health of DPS populations. Given the connectivity of most DPS units with lynx populations and habitats in Canada, the noted dispersal capabilities of lynx, evidence of dispersal in both directions across the Canada-U.S. border (Aubry *et al.* 2000, pp. 386-387; Squires *et al.* 2006a, p. 38; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and the small number of immigrants thought necessary to maintain genetic variability in peripheral populations (McKelvey *et al.* 2000b, pp. 23-24), genetic isolation, biologically meaningful genetic drift, or potential genetic ‘‘bottlenecks’’ appear unlikely among most DPS populations in the future (79 FR 54793).

Within the contiguous U.S., minor genetic sub-structuring has been documented among lynx subpopulations in western Montana (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5). Additionally, lynx-bobcat hybridization has been documented in Minnesota, Maine and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where male bobcats bred with female lynx to produce fertile offspring with lynx-like ear tufts, intermediate foot-size, and bobcat-like fur (ILBT 2013, p. 35). In Minnesota from 2000 to 2015, DNA analyses documented 13 distinct hybrid individuals (Moen and Catton *in* Lynx SSA Team 2016, pp. 13, 19); no hybrids have been documented in the western portion of the lynx’s range (Schwartz *in* Lynx SSA Team 2016, p. 12).

2.2 Life History and Population Dynamics

All aspects of lynx life history are inextricably tied to its primary prey, the snowshoe hare (Figure 6). Snowshoe hares comprise a majority of the lynx diet throughout its range (Nellis *et al.* 1972, pp. 323–325; Brand *et al.* 1976, pp. 422–425; Koehler 1990, p. 848; Apps 2000, pp. 358–359, 363; Aubry *et al.* 2000, pp. 375–378; Mowat *et al.* 2000, pp. 267–268; von Kienast 2003, pp. 37–38; Squires *et al.* 2004a, p. 15, Table 8, Olson 2015, pp. 60-69), and hare abundance is the major driver of lynx population dynamics. Lynx den site selection, litter sizes, pregnancy, as well as recruitment, survival (kitten, subadult and adult) and dispersal rates, and population age structure, home range sizes, density, and distribution are all strongly influenced by hare abundance (Koehler and Aubry 1994, pp. 75-76, 80-83; Apps 2000, entire; Aubry *et al.* 2000, pp. 375-390; Mowat *et al.* 2000, pp. 270-294; ILBT 2013, pp. 18, 22-24, 26-34).

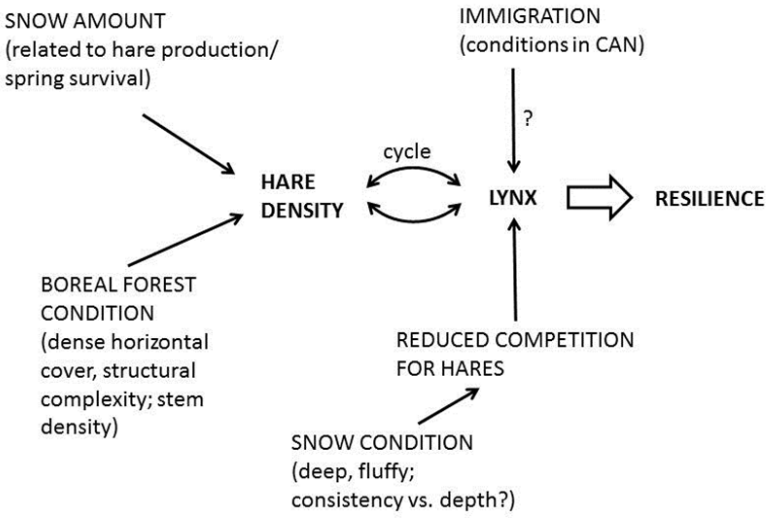


Figure 6. Generalized relationship between habitat conditions and hare and lynx population dynamics and their influence on lynx population resiliency.

Lynx are highly specialized predators of snowshoe hares and are dependent on landscapes with high-density snowshoe hare populations for survival and reproduction (McCord and Cardoza 1982, p. 744; Quinn and Parker 1987, pp. 684-685; Aubry *et al.* 2000, pp. 375-378). Lynx and snowshoe hares are strongly associated with what is broadly described as boreal forest (Bittner and Rongstad 1982, p. 154; McCord and Cardoza 1982, p. 743; Quinn and Parker 1987, p. 684; Agee 2000, p. 39; Aubry *et al.* 2000, pp. 378-382; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-191; McKelvey *et al.* 2000a, pp. 211-232). The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (*Picea* spp.) and fir (*Abies* spp.) (Elliot-Fisk 1988, pp. 34-35, 37-42). Snowshoe hares feed on conifers, deciduous trees, and shrubs (Hodges 2000b, pp. 181-183) and are most abundant in forests with dense understories that provide forage, cover to escape from predators, and protection during extreme weather (Wolfe *et al.* 1982, pp. 665-669; Litvaitis *et al.* 1985, pp. 869-872; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-195). Over much of the lynx's range, hare densities are higher in regenerating, earlier successional forest stages because they often have greater understory structure than mature forests (Buehler and Keith 1982, p. 24; Wolfe *et al.* 1982, pp. 665-669; Koehler 1990, pp. 847-848; Hodges 2000b, pp. 183-195; Homyack 2003, pp. 63, 141; Griffin

2004, pp. 84-88). However, snowshoe hares also can be abundant in mature forests with dense understories, particularly in the Northern Rocky Mountains (Griffin 2004, pp. 53-54; Griffin and Mills 2009, pp. 1492-1496; Hodges *et al.* 2009, p. 876; Squires *et al.* 2010, pp. 1653-1657; Berg *et al.* 2012, pp. 1483-1487). These mature forests may be a source of hares for other adjacent forest types (Griffin and Mills 2009, pp. 1492, 1495-1496), and they may provide especially important winter foraging habitats (Squires *et al.* 2010, pp. 1655-1657), which may be the most limiting habitat for lynx (Squires *et al.* 2010, pp. 1655-1657; ILBT 2013, pp. 17, 27). They also are more temporally-stable (i.e., they provide high-quality hare habitat for a longer period of time) than regenerating stands, which may foster high hare densities for a variable window of time between stand-initiation and stem-exclusion stages of succession, after which they may persist, in the absence of disturbance, for many years as lower-quality hare habitat (ILBT 2013, pp. 62, 71, 127).

Lynx habitat can generally be described as moist boreal forests that have cold, snowy winters and a snowshoe hare prey base (Quinn and Parker 1987, pp. 684-685; Agee 2000, pp. 39-47; Aubry *et al.* 2000, pp. 373-375; Buskirk *et al.* 2000b, pp. 397-405; Ruggiero *et al.* 2000b, pp. 445-447). Because lynx population dynamics, survival, and reproduction are closely tied to snowshoe hare availability, snowshoe hare habitat is the primary component of lynx habitat. However, lynx do not occur everywhere within the range of snowshoe hares in the contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729). This may be due to inadequate abundance, density, or spatial distribution of hares in some places, or the absence of snow conditions that would allow lynx to express a competitive advantage over other hare predators, or a combination of these factors (79 FR 54809).

The boreal forest landscape is naturally dynamic. Forest stands within the landscape change as they undergo succession after natural or human-caused disturbances such as fire, insect epidemics, wind, ice, disease, and forest management (Elliot-Fisk 1988, pp. 47-48; Agee 2000, pp. 47-69). As a result, lynx habitat within the boreal forest landscape is a shifting mosaic of habitat patches of variable and continually changing quality (68 FR 40077). These stands of differing ages and conditions provide lynx foraging or denning habitat (or may provide these in the future depending on patterns of disturbance and forest succession), and some serve as travel routes for lynx moving between foraging and denning habitats (McKelvey *et al.* 2000c, pp. 427-434; Hoving *et al.* 2004, pp. 290-292). Lynx generally concentrate hunting activities in areas where snowshoe hare densities are high (Koehler *et al.* 1979, p. 442; Ward and Krebs 1985, pp. 2821-2823; Murray *et al.* 1994, p. 1450; O'Donoghue *et al.* 1997, pp. 155, 159-160 and 1998, pp. 178-181; Fuller and Harrison 2010, entire; Simons-Legaard *et al.* 2013, pp. 573-575). Because understory density within a forest stand changes over time, hare habitat quality and corresponding hare densities also shift continually across boreal forest landscapes.

Hare populations in the core of the lynx range in Canada and Alaska undergo well-documented dramatic 8 to 11 year cycles during which hare numbers may fluctuate 10 to 25 fold or more, with peak densities as high as 23 hares/hectare (ha; 9.3 hares/acre [ac]) and lows of 0.1/ha (0.04/ac) (Hodges 2000a, pp. 117-121; Vashon 2015, p. 4). Hare densities are generally lower at the southern periphery of lynx distribution, and hare population cycles are generally much

less pronounced or absent entirely among some hare populations in southern Canada and in the contiguous U.S. (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17). In the contiguous U.S., stand-level hare densities may exceed 2 hares/ha (0.8 hares/ac) (Walker 2005, pp. 20, 85; McCann 2006, p. 15; Robinson 2006, pp. 26-36, 62-75; Homyack *et al.* 2007, pp. 10-11; Griffin and Mills 2009, p. 1492; Vashon *et al.* 2012, p. 14), but in many parts of the DPS, landscape-level densities are lower, ranging from just above to well below the 0.5 hares/ha (0.2/ac) density thought necessary to sustain lynx home ranges and populations (Hodges 2000b, pp. 168-169, 185; Ruggiero *et al.* 2000b, pp. 446–447; Squires and Ruggiero 2007, pp. 313-314; Maletzke *et al.* 2008, pp. 1476-1477; Zahratka and Shenk 2008, pp. 910-911; Hodges *et al.* 2009, pp. 873-877; Ivan 2011a, pp. 91-92, 95-102; Berg *et al.* 2012, p. 1483; ILBT 2013, pp. 24, 26, 90).

During lows in snowshoe hare populations, lynx prey opportunistically on other small mammals, especially red squirrels (*Tamiasciurus hudsonicus*), and birds, but alternate prey species do not sufficiently compensate for low availability of snowshoe hares, and lynx populations cannot persist over time in areas with consistently low hare densities (Brand *et al.* 1976, pp. 422–425; Brand and Keith 1979, pp. 833–834; Koehler 1990, pp. 848–849; Mowat *et al.* 2000, pp. 267–268). Nonetheless, even in areas with relatively low or marginal hare densities, hares constitute the majority of the biomass in lynx diets (Koehler and Aubry 1994, p. 85; Apps 2000, pp. 362-363; Aubry *et al.* 2000, pp. 375-378; Roth *et al.* 2007, pp. 2740-2741; Squires and Ruggiero 2007, pp. 310-313; Hanson and Moen 2008, p. 9; Maletzke *et al.* 2008, pp. 1475-1477; Shenk 2009, pp. 13, 16; Ivan *in* Lynx SSA Team 2016, Appendix 3, pp. 13-14).

Lynx typically mate in March and April, and kittens are born from late April to mid-June after a 60- to 70-day gestation period (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Female lynx typically reach reproductive maturity in their second year (at 22 months of age); however, when hares are abundant, females may breed at 10 months of age and produce kittens as 1-year-olds (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Males do not seem to breed as yearlings, and they do not contribute to rearing of young (ILBT 2013, p. 30). Lynx dens are typically located in areas of dense cover, where coarse woody debris, such as downed logs and windfalls, provides security and thermal cover for lynx kittens (McCord and Cardoza 1982, pp. 743-744; Koehler 1990, pp. 847-849; Slough 1999, p. 607; Squires and Laurion 2000, pp. 346-347; Organ *et al.* 2008, entire; Squires *et al.* 2008, pp. 1497, 1501-1505; Moen and Burdett 2009, entire). Dens have been documented in both mature and younger boreal forest stands (Mowat *et al.* 2000, pp. 274-275; Squires *et al.* 2008, p. 1497; ILBT 2013, pp. 29-30; 78 FR 59441-59442; 79 FR 54809-54810; Organ *et al.* 2008, entire), and the amount of structure (e.g., downed, large, woody debris, tip-up mounds) seems to be more important than the age of the forest stand for lynx denning habitat (Mowat *et al.* 2000, pp. 274-275, Organ *et al.* p. 1516). Denning habitat is not thought to be a limiting factor for lynx in the DPS (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517; Squires *et al.* 2008, p. 1505; ILBT 2013, p. 30; 79 FR 54790). Dens must be near foraging habitat to allow females to adequately provision dependent kittens, and females seem to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.*

2012, p. 16; ILBT 2013, p. 29). Females attend kittens at the natal den site and one or more alternate or maternal dens until kittens are about 6-10 weeks old (Squires *et al.* 2008, p. 1502; Vashon *et al.* 2012, p. 17; ILBT 2013, p. 29). Thereafter, kittens remain with their mothers through their first winter, apparently learning from her how to hunt and capture prey, initially on a small portion of her home range, but by fall on the larger area the female used before kittens were born (Mowat *et al.* 2000, pp. 269, 278). Juveniles remain closely associated with their mothers until February or March, when family groups begin to break up, with young typically dispersing in April and May (Mowat *et al.* 2000, pp. 278-279) to establish their own home ranges. Female offspring may establish home ranges overlapping or adjacent to their mother's home range and maintain mother-daughter bonds throughout their lives (Mowat *et al.* 2000, pp. 279-280). Male home ranges may slightly overlap adjacent male home ranges. While male home ranges typically overlap one to three female home ranges, and female home ranges are partially or completely encompassed by a male's home range, core areas within home ranges appear to be exclusive except during the breeding season (Koehler and Aubry 1994, pp. 90-91; Mowat *et al.* 2000, pp. 276-280; Vashon *et al.* 2012, pp. 17, 22-23). Fidelity to home ranges over several years has been documented for both sexes, but shifts and abandonment of home ranges have also been documented (Koehler and Aubry 1994, p. 91; Mowat *et al.* 2000, p. 277). Lynx have been documented to live up to 16 years in the wild (Kolbe and Squires 2006, entire).

Lynx populations in Canada fluctuate in response to the cycling of hare populations (Elton and Nicholson 1942, pp. 241–243; Hodges 2000a, pp. 118–123; Mowat *et al.* 2000, pp. 265–272), with synchronous fluctuations in lynx numbers emanating from the core of the Canadian population and spreading over vast areas, generally lagging hare numbers by one year (McKelvey *et al.* 2000a, pp. 232, 239; Mowat *et al.* 2000, pp. 266, 270). When hares are abundant, lynx have higher pregnancy rates and larger litter sizes, higher kitten survival, and lower adult mortality, resulting in rapid population growth during the increase phase of the hare cycle (Slough and Mowat 1996, pp. 955–956; Mowat *et al.* 2000, pp. 266, 270–272, 281–289). When hare populations are low, female lynx produce few or no kittens that survive to independence (Nellis *et al.* 1972, pp. 326–328; Brand *et al.* 1976, pp. 420, 427; Brand and Keith 1979, pp. 837–838, 847; Poole 1994, pp. 612–616; Slough and Mowat 1996, pp. 953–958; O'Donoghue *et al.* 1997, pp. 158–159; Aubry *et al.* 2000, pp. 388–389; Mowat *et al.* 2000, pp. 285–287). When hares decline, lynx mortality rates increase, largely because of starvation, and home range sizes and dispersal/ emigration rates also increase (Ward and Krebs 1985, pp. 2821–2823; O'Donoghue *et al.* 1997, pp. 156, 159; Poole 1997, pp. 499–503; Mowat *et al.* 2000, pp. 265–272, 278, 281–294). Lynx numbers decline dramatically during the ''crash'' phase of the hare cycle (Slough and Mowat 1996, p. 956; Mowat *et al.* 2000, pp. 283-285), when many lynx starve and many others abandon home ranges and disperse in search of food, with many of the latter also dying, often soon after initiating dispersal (Mowat *et al.* 2000, p. 293).

In Canada, lynx abundance may be 3 to 17 times higher at the peak versus the low of the hare cycle, with lynx densities reaching 30-45/100 km^2 (78-117/100 mi^2) in optimal dense regenerating forests 15-40 years post-fire, 8-20/100 km^2 (21-52/100 mi^2) in older forests or further south, and < 3/100 km^2 (< 8/100 mi^2) at the hare cycle low (Slough and Mowat 1996, pp.

952, 955; Mowat *et al.* 2000, p. 283; Hatler and Beal 2003, pp. 2, 5; Environment Canada 2014, p. 1). In southern Canada, where hares are less abundant and hare population cycles are muted or absent, lynx populations may be stable at 2-3/100 km^2 (5-8/100 mi^2) (Environment Canada 2014, p. 1). Lynx densities estimated in the contiguous U.S. have ranged from 9.2-13/100 km^2 (24-34/100 mi^2), including kittens, in Maine's highest-quality habitat when hares were abundant (Vashon *et al.* 2008, pp. 1483-1484; Vashon *et al.* 2012, pp. 14-15) to 2.3/100 km^2 (6/100 mi^2) in Washington when hare abundance was low (Koehler 1990, pp. 847-850). Correspondingly, hare abundance may also influence lynx home range size. Ward and Krebs (1985, pp. 2819-2820) documented a 3-fold increase in home range size in southwestern Yukon, from 13 km^2 (5 mi^2) on average when hares were abundant and increasing to 39 km^2 (15 mi2) when hare density was low. Poole (1994, pp. 613-614) documented a similar trend in the Northwest Territories, where lynx home range size increased from 17 km^2 (7 mi^2; males and females combined) when hares were abundant, to 44 km^2 (17 mi^2) and 62 km^2 (24 mi^2) for males and females, respectively, when hare numbers declined. In contrast, Breitenmoser *et al.* (1993, p. 552) reported no change in lynx home range size despite a 10-15 fold increase in lynx density as hare abundance increased in the southern Yukon. Similarly, in Maine, lynx home range size did not increase when hare densities declined from 2/ha (0.8/ac) to 1/ha (0.4/ac) (Mallett 2014, pp. 53-93). In general, hare and lynx densities are lower and lynx home ranges larger at the southern periphery of the lynx's range, including most of the contiguous U.S., and are similar to those of northern populations during the low phase of the hare population cycle (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367).

Lynx populations in the contiguous U.S. seem to function as subpopulations or southern extensions of larger populations in northern and eastern Canada (McKelvey *et al.* 2000b, pp. 21, 25, 33; 65 FR 16052–16082; 68 FR 40077–40099; 71 FR 66025–66035; 74 FR 8616–8641; Koen *et al.* 2015, pp. 527-528). Populations in the DPS are relatively isolated from one another, though most are directly connected via dispersal to lynx populations in Canada (McKelvey *et al.* 2000b, pp. 25-34; U.S Fish and Wildlife Service 2005, p. 2). Lynx disperse in both directions across the Canada–U.S. border (Aubry *et al.* 2000, pp. 386-387; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and this connectivity and interchange with lynx populations in Canada is thought to be important to the conservation of lynx populations in the DPS. (McKelvey *et al.* 2000b, p. 33; Schwartz *et al.* 2002, p. 522; U.S Fish and Wildlife Service 2005, p. 2; ILBT 2013, p. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187). However, whether and, if so, to what the extent the demographic and genetic health and persistence of populations in the DPS depend on regular or intermittent immigration of lynx from Canada remains uncertain (McKelvey *et al.* 2000a, pp. 241-242; 79 FR 54793).

2.2.1 Ecological Requirements of Individuals

At the most fundamental level, the needs of an individual lynx are met if:

1) it is born to a female that occupies a home range containing
    a) secure denning habitat,

b) adequate hare abundance to support lactation during the early kitten stage and later provisioning of the kitten with hare meat,
c) habitat (boreal forest and snow) conditions that reduce the likelihood and effect of competition from other hare predators, and
d) a low likelihood of encounters with lynx mortality agents (predators, trappers, vehicles, etc.);

2) the mother's home range occurs within a larger landscape that also contains adequate hare abundance and available habitat into which the yearling lynx may disperse and establish its own home range after the period of maternal dependence, with low likelihood of adverse competition and mortality; and

3) the larger landscape also supports other secure lynx home ranges and ensures the opportunity to encounter a lynx of the opposite sex, breed successfully, and contribute to the recruitment of at least one offspring into the breeding population during its lifetime.

In cyclic northern lynx populations, there is a strong element of timing that determines whether these individual needs will be met. During the decline and low phases of the hare population cycle, few kittens are born, very few survive until their first winter, and recruitment may collapse completely or nearly so for several successive years (Slough and Mowat 1996, entire; Mowat *et al*. 2000, pp. 266, 285-287). Therefore, even in the core of the species' range, a kitten born during a period of declining or low hare abundance is very unlikely to survive to independence, breed successfully, and replace itself within the breeding population in its lifetime. Conversely, a kitten born during the increase or high phase of the hare population cycle is much more l kely to survive, establish a home range, breed successfully, and replace itself via recruitment of one or more of its offspring into the breeding population.

In southern lynx populations (southern Canada and the contiguous U.S.), hare population cycles are of lower amplitude or absent (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17), and hare and lynx abundances and lynx demographic rates are typically like those of northern populations during hare lows (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367). Therefore, the likelihood that an individual lynx will have its ecological requirements met sufficiently so that it may replace itself in the breeding population is probably consistently relatively low, perhaps similar to lynx born during hare declines/lows in the north. Also in the south, there are more diverse assemblages of potential competitors and predators, more natural patchiness and anthropogenic fragmentation of lynx habitat (fewer areas with adequate hare densities and favorable snow conditions distributed broadly across large landscapes), and higher road densities and, thus, greater potential for lynx-vehicle collisions (Wolff 1980, p. 128; Buskirk *et al*. 2000a, entire). These factors probably further reduce the l kelihood that an individual lynx in the southern periphery of the range will survive, reproduce successfully, and have one or more offspring recruited into the resident breeding population.

Individual lynx require large areas of boreal forest landscapes to support their home ranges, provide hares in adequate abundance to meet their nutritional needs, provide breeding opportunities, and facilitate dispersal and exploratory travel. Female home ranges must also provide secure denning habitat in close proximity to foraging areas with high hare densities to allow females to adequately provision dependent kittens, and females appear to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). The size of lynx home ranges is strongly influenced by the quality of the habitat, particularly the abundance of snowshoe hares, in addition to other factors such as gender, age, season, and density of the lynx population (Aubry *et al.* 2000, pp. 382–385; Mowat *et al.* 2000, pp. 276–280). Generally, females with kittens have the smallest home ranges, l kely related to their need to stay close to dens and dependent kittens, and males have the largest home ranges (Moen *et al.* 2005, p. 11; Burdett *et al.* 2007, p. 463; ILBT 2013, p. 24).

The increased natural patchiness and fragmentation of high-quality hare habitat where boreal forest conditions transition to temperate forest types require individual lynx in many parts of the DPS to maintain relatively large home ranges that include patches of higher hare densities within a matrix of lower-quality habitats with lower hare densities (ILBT 2013, p. 126; 78 FR 59434; also see 2.3.3, below). Larger home ranges l kely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range (78 FR 59438). Annual home range sizes reported for lynx in the contiguous U.S. (Table 2, below) vary greatly across the DPS but are generally larger in the west than the east; however, differences should be interpreted with caution because different methods, sample sizes, and estimators were used to generate them (ILBT 2013, pp. 23-24).

Table 2. Reported annual home range sizes for Canada lynx in the contiguous United States.

Geographic Unit	Reported Lynx Home Range Size km² (mi²)		References (pages)
	Female	Male	
N Maine	26 (10)	54 (21)	Vashon *et al.* 2012 (16-17)
NE Minnesota	17-21 (7-8)	160-267 (62-103)	Burdett *et al.* 2007 (460-463); Moen *et al.* 2008a (17)
NW Montana/ NE Idaho	43-115 (17-44)	122-238 (47-91)	Brainerd 1985 (20); Squires and Laurion 2000 (344); Squires *et al.* 2004a (13)
N-C Washington	37-91 (14-35)	49-69 (19-27)	Brittell *et al.* 1989 *in* Stinson 2001 (5); Koehler 1990 (847); Maletzke *in* Lynx SSA Team 2016 (21)
GYA	50 (19)	824 (318)	Squires *et al.* 2003 (12-13)

Commented [29]: Some of these home ranges seem to be presented as a range of values and others (e.g., ME, GYA) are a single value (a mean?). We should be consistent and present a mean and range, if these data are available.

W Colorado	75-704 (29-272)	103-387 (40-149)	Shenk 2008 (10)

Juvenile and adult lynx require about 400 and 600 grams (14 and 21 ounces) of food per day (for adults, 0.4-0.5 hares/day, 170-200 hares/year), respectively, to meet their basic nutritional requirements (Saunders 1963, p. 390; Nellis *et al.* 1972, pp. 324-325). Available research suggests that landscape-level hare densities >= 0.5 hares/ha (0.2/ac) are necessary to support lynx home ranges and resident breeding populations; lynx home range abandonment, dispersal, and mortality increase when hare densities are lower; and lynx may be unable to survive where landscape hare densities are below 0.3/ha (0.12/ac) (Ward and Krebs 1985, pp. 2819-2822; Slough and Mowat 1996, entire; Ruggiero *et al.* 2000b, pp. 446-447; ILBT 2013, pp. 26, 125). Recent research in the contiguous U.S. supports this - in northern Maine, areas with landscape hare densities of 0.74/ha (0.30/ac) supported resident breeding lynx, but areas with hare densities below 0.5/ha (0.2/ac) were not occupied by lynx (Simons-Legaard *et al.* 2013, pp. 567, 574-575). Likewise, in northeastern Minnesota, resident lynx maintained home ranges where landscape hare densities were 0.64/ha (0.26/ac). Voyageurs National Park, where hare density was estimated at 0.35/ha (0.14/ac), did not support resident breeding lynx (Moen *et al.* 2012, pp. 352–354).

In addition to adequate hare density, individual lynx require landscapes in which they are unlikely to encounter predators (mountain lion [*Puma concolor*], coyote [*Canis latrans*], wolverine [*Gulo gulo*], gray wolf [*Canis lupus*], fisher [*Pekania pennanti*], and other lynx) (ILBT 2013, pp. 33, 35). Although lynx have co-evolved with predators, the influence of predation on lynx populations is unknown (ILBT 2013, pp. 35-36), and mountain lions and coyotes are now more widespread and abundant in the southern periphery of the lynx distribution than they seem to have been historically (Buskirk *et al.* 2000a, p. 83; Gompper 2002, entire). Lynx also need landscapes where they are unlikely to suffer reduced fitness because of competition with other hare predators, or encounter traps or other anthropogenic causes of mortality. Except for fisher and marten (*Martes americana*), lynx predators and potential terrestrial competitors for hares (the species above plus bobcat; maybe red fox [*Vulpes vulpes*] in some situations) all have higher foot-loading (weight per surface area of the foot), making them less efficient at traveling and hunting in the deep powdery snow conditions favorable for lynx (Buskirk *et al.* 2000a, pp 86-95, Krohn *et al.* 2005, entire) and, therefore, likely limiting, at least seasonally, interactions between lynx and these species. Analysis of lynx occurrence data in the contiguous U.S. suggests that lynx require at least four months (December through March) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Where snow conditions do not consistently favor lynx, increased potential for predation and competition would be expected (Peers *et al.* 2013, p. 8). Finally, individual lynx are more likely to survive, breed, and replace themselves in the breeding population if they occupy home ranges where trapping is prohibited or trapping pressure is low (Slough and Mowat 1996, entire), high-speed/ high-volume roadways are absent (ILBT 2013, pp. 77-78), and other potential anthropogenic causes of lynx mortality are minimal.

In summary, individual lynx require large landscapes with hare densities that maximize their chances of (1) surviving to independence, (2) establishing and maintaining a home range, (3) breeding successfully, and (4) contributing genes to future generations (Breitenmoser *et al.*

1993, p. 552). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. The available science suggests that landscape-level hare densities consistently >= 0.5 hares/ha (0.2/ac) and favorable snow depth and conditions for about 4 months are needed to support lynx occupancy, reproduction, and recruitment. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or to do so inconsistently.

2.2.2 Ecological Requirements of Populations and the DPS

Lynx populations require essentially the same things that individual lynx do (see Figure 5 and section 2.2.1, above), but on a larger landscape with hare densities and habitat conditions capable of consistently supporting multiple home ranges, breeding and dispersal opportunities, and reproductive and survival rates such that recruitment and immigration will, on average over the long term, equal or exceed mortality and emigration (Pulliam 1988, pp. 652-654). To support persistent lynx populations, such landscapes must provide for the survival of at least some resident lynx even when hares are least abundant and/or other habitat features (e.g., snow conditions) are least favorable so that the population can recover, perhaps aided by immigration, when hare numbers and/or other habitat conditions recover or improve. As with individual lynx, populations are more likely to persist in landscapes where the effects of competition, predation, and human-caused mortality (e.g., trapping, vehicle collisions) are relatively lower.

In a mainland-island metapopulation structure l ke that thought to govern lynx population dynamics, the persistence of peripheral island populations is determined by colonization and extinction rates (McKelvey *et al.* 2000b, p. 25). Colonization is driven by the number of islands, the distances between them, and the species' dispersal capabilities and timing. Extinction rates are determined by population size and demographic and environmental stochasticity, with extinction more likely in smaller and more isolated populations (McKelvey *et al.* 2000b, pp. 25-31). Lynx populations in the DPS are at the periphery of the species' range and may behave as islands in a mainland-island metapopulation construct. In such a system, larger islands with higher habitat quality and in closer proximity to the mainland would be more likely to support persistent resident populations and to sometimes act as "sources" that produce surplus animals that may disperse to other islands. Smaller islands with lower habitat quality or at greater distance from the mainland may, in contrast, act as "sinks" that depend on immigration from source populations (McKelvey *et al.* 2000b, p. 30), and which may support resident lynx only occasionally, intermittently, or temporarily.

Formal population viability analyses (PVAs) have not been published for lynx populations in the DPS and may not be possible given limited data and natural temporal variation in demographic rates (McKelvey *et al.* 2000a, pp. 22, 30). Although some demographic data are available for most lynx populations in the DPS, most are limited to relatively few, small study areas or relatively short durations. There remains uncertainty about whether, and if so to what extent, the demographic health of DPS populations relies on immigration from northern (Canadian)

populations; and immigration rates are not known for DPS populations (McKelvey *et al.* 2000a, pp. 24-34). These factors likely preclude development of meaningful DPS-wide or unit-specific empirical population viability models (McKelvey *et al.* 2000b, p. 22).

Slough and Mowat (1996, p. 952, Table 4) calculated population growth rate (lambda, λ) = 2.03 (annual doubling) during the 4-year increase-to-peak phase for a lynx population in the core of the species' range in southern Yukon. This period of rapid growth was followed by a rate of λ = 1.01 (stable) during the first year of a hare decline, and λ = 0.10 and λ = 0.46 (rapid decline) during the first two years of the lynx population decline when hares were scarce. (Note – the value λ = 0.01 presented in Slough and Mowat (1996, p. 952, Table 4) appears to be an error; the correct value for λ in a population in which the estimated number of individuals declined from 135 in 1992 to 13 in 1993 should be 13/135 = 0.10 [as presented above]). However, the natural range in λ that would be expected among peripheral, isolated, or semi-isolated lynx populations where hares are non-cyclic or weakly-cyclic (i.e., in DPS populations), versus those that would signal long-term population decline or instability is unknown. Despite this, and the limitations noted above, Squires (*unpubl. data in* Lynx SSA Team 2016, p. 20) calculated population growth rates in northwestern Montana of λ = 0.92 for lynx in the Seeley Lake area (i.e., declining population trend, 1999-2007) and λ = 1.16 for lynx in the Purcell Mountains (increasing trend, 2003-2007). Likewise, McCollough (2016 *unpubl. data*; USFWS, Vortex10, deterministic population simulation) used demographic data from Vashon *et al.* 2012 (pp. 17-21) to calculate finite growth rates during a period of high hare density (λ = 1.16; increasing trend) and during a period of low hare density (λ = 0.88; decreasing trend) for the lynx population in northern Maine (see also section 4.1.1, below).

Although minimum viable population sizes have not been derived for lynx populations in the DPS, the Service's Recovery Outline (USFWS 2005, p. 5) suggested landscapes of at least 1,250 km^2 (483 mi^2) with sufficient boreal/subalpine habitat, hare densities (at least 0.5 hares/ha [0.2/ac]), and snow conditions favorable for lynx ("fluffy and/or deep...for sufficient periods to favor the competitive advantage of lynx"). These are the minimum landscape size and habitat conditions thought necessary to support a minimum lynx population of at least 25 adults based on a lynx density of one lynx per 50 square kilometers (USFWS 2005, p. 5). McKelvey *et al.* (2000b, p. 29) noted that extinction (extirpation) risk should decrease with increasing population size, and that extinction resulting from demographic stochasticity is very unlikely even for a population (generally; not specific to lynx) with as few as 20 reproducing females. Kramer-Schadt *et al.* (2005, entire) developed a spatially explicit population model for Eurasian lynx in Germany which they combined with demographic scenarios to evaluate the likely success of potential reintroduction efforts; they concluded that at least 10 females and 5 males would be required to establish a population with an extinction probability less than 5 percent over 50 years. Rodriguez and Delibes (2003, entire) evaluated extinction among populations of Iberian lynx; they found that extinction occurred only in small populations that occupied habitats of less than 500 km^2 and that extinction within 35 years was unlikely among populations occupying areas of at least 500 km^2 of adequate habitat quality.

In summary, lynx populations need large boreal forest landscapes with snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. These landscapes must have hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term. Immigration may be particularly important to the persistence and stability of lynx populations at the southern periphery of the range, including those within the DPS, where hare densities are generally low and hare populations are either non-cyclic or weakly-cyclic compared to northern populations. Low hare densities reduce the likelihood that lynx recruitment will consistently equal or exceed mortality, and non-cyclic or weakly-cyclic hare populations are unlikely to allow the rapid lynx population recovery observed in northern lynx populations when hare numbers increase dramatically after cyclic population crashes. Although immigration rates for DPS populations are unknown, as is the rate and periodicity of immigration needed to provide demographic stability among them, connectivity with and immigration from lynx populations in Canada is believed to be important to the persistence of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789).

2.3 Historic and Current Lynx Distribution

2.3.1 Lynx Distribution and Status in Canada and Alaska

The Canada lynx is broadly distributed across northern North America from eastern Canada to Alaska (McCord and Cardoza 1982, p. 729; Poole 2003, p. 361; Vashon 2015, p. 4; Alaska Center for Conservation Science 2016, p. 1). It is strongly associated with the expansive, continuous boreal forests of those areas, and its range largely overlaps that of its primary prey, the snowshoe hare, also a boreal forest specialist (Bittner and Rongstad 1982, p. 146; Mowat *et al.* 2000, pp. 268-269; Aubry *et al.* 2000, p. 375). In Canada, lynx are thought to occupy about 5.5 million km^2 (over 2.1 million mi^2), which represents 95 percent of their historic range in that country (Environment Canada 2014, p. 2), and over 89 percent of the species' entire distribution. Nationally in Canada, lynx are classified as secure, widespread, and abundant; they are managed for long-term population stability, with a conservative estimate of 110,000 individuals during cyclic lows; and no acute, widespread threats to lynx have been identified (Environment Canada 2014, entire; Vashon 2015, pp. 1-6). Provincially, lynx status is considered secure in British Columbia, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Northwest Territories, and the Yukon; sensitive in Alberta and Saskatchewan; at risk/endangered in New Brunswick and Nova Scotia; and undetermined in Nunavut (Environment Canada 2014, pp. 3-4; Vashon 2015, p. 1). Lynx were extirpated from Prince Edward Island (0.1 percent of lynx range in Canada) by the late 1800s, and on the mainland the southern margin of assumed lynx range has contracted northward in Quebec, southeastern

Ontario, Manitoba, Saskatchewan, and Alberta (Poole 2003, p. 361; Bayne *et al.* 2008, pp. 1192-1195; Koen *et al.* 2014, pp. 757-760).

In Alaska, lynx are distributed across roughly 534,454 km^2 (206,354 mi^2) of boreal forest habitats (University of Alaska Center for Science Conservation, http://akgap.uaa.alaska.edu/species-data/canadian-lynx-annual-distribution/#content, accessed 4/28/2016; Reimer 2016, pers. comm.), which represents about 8.7 percent of the species' distribution. Lynx in Alaska are apparently secure, with low to moderate threats, and populations appear stable statewide, although total abundance is unknown (Alaska Natural Heritage Program 2008, pp. 2-4). In both Alaska and Canada, lynx trapping is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Alaska Natural Heritage Program 2008, pp. 2-6; Vashon 2015, pp. 5-6). Along the Canada-U.S. border in provinces adjacent to DPS lynx populations, lynx trapping is prohibited in New Brunswick (adjacent to northeastern Maine) but regulated trapping is permitted in Quebec (adjacent to northwestern Maine, northern New Hampshire, and northern Vermont), Ontario (adjacent to northeastern Minnesota), Alberta (adjacent to northwestern Montana), and British Columbia (adjacent to northwestern Montana, northern Idaho, and northern Washington).

2.3.2 Lynx Distribution in the Contiguous United States

2.3.2.1 Defining Lynx Distribution at the Periphery of the Range

Several aspects of lynx population dynamics and dispersal patterns have resulted in inconsistent approaches and difficulty in defining the range and/or distribution of the species, especially at the margins (74 FR 66942). These, combined with uncertainty and ambiguity in the historical record of lynx occurrence, with early assessments based largely on trapping harvest records of questionable accuracy, particularly where lynx and bobcats overlap, and a reliance on anecdotal or unverified occurrence information (McKelvey *et al.* 2000a, pp. 208-210; 65 FR 16054), confound efforts to accurately portray the species' historical distr bution in the contiguous U.S. and to assess the current distribution relative to historic conditions (79 FR 54814-54815; McKelvey *in* Lynx SSA Team 2016, p.11). They also have resulted in inaccurate portrayals of lynx distribution and misperceptions that the historic range of lynx in the contiguous U.S. was once much more extensive than is ecologically possible (68 FR 40080; 74 FR 66942).

The range of the lynx must be considered differently from those of other species that are less mobile and have more stable population dynamics. Because the lynx is highly mobile and has cyclic population dynamics that are tied to cyclic snowshoe hare populations, numbers of lynx naturally fluctuate and become extremely low at times during a cycle. Additionally, where snowshoe hare populations are not adequate, resident lynx populations cannot be sustained. Because of this, resident lynx populations never occurred everywhere boreal forest existed in the contiguous U.S. Where the boreal forest was naturally more patchy and marginal, the habitat was incapable of supporting an adequate snowshoe hare population that in turn was incapable of supporting a resident lynx population over time. As a result, only a few areas in the

contiguous U.S. historically supported an adequate quantity and quality of habitat to support resident lynx populations over time, and many historical lynx occurrences across a large area of the contiguous U.S. were likely dispersers. The occurrence of dispersing lynx is unpredictable, and dispersing lynx will likely continue to periodically move into areas that are not lynx habitat (68 FR 40077).

The dramatic, cyclic fluctuations in lynx populations across much of the range as they track cyclic hare populations and the mass synchronous dispersals (irruptions) of large numbers of lynx into the contiguous U.S. when northern hare populations crashed are well-documented (Elton and Nicholson 1942, entire; Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 219, 232-242; Mowat *et al.* 2000, pp. 281-294; ILBT 2013, p. 33). These events have resulted in records of lynx occurrence, in some cases very rarely, in others sometimes in large numbers and with intermittent (cyclic) regularity, in places that otherwise lack evidence of persistent lynx presence or the habitats and hare densities necessary to support a resident lynx population (U.S. Fish and Wildlife Service 2005, pp. 3-4; 79 FR 54787-54789, 54793-54795, 54812-54823). Many records of lynx in the contiguous U.S. appear to be related to such events, including the unprecedented ‘‘explosions’’ of lynx observed in the early 1960s and 1970s (Gunderson 1978, entire; McKelvey *et al.* 2000a, pp. 232-242). During these events, many lynx occurred in anomalous habitats, exh bited unusual behavior, suffered high mortality, and numbers declined dramatically within a few years of irruptive peaks (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, p. 242). Because dispersing lynx typically do not persist in these areas of temporary range expansion, disappearing fairly quickly after irruptions, van Zyll de Jong (1971, p. 16), suggested that only areas that support lynx populations throughout both the low and the high phases of the “10-year cycle” (i.e., across the natural range of hare densities) should be considered to constitute the species’ range. In its 2003 remanded determination, the Service determined that lynx in the contiguous U.S.exist either as resident populations or as dispersers, that dispersing lynx are often found repeatedly and for variable amounts of time in habitats that cannot sustain breeding populations over time (though some breeding may occur occasionally in some of these areas), and that such areas probably contribute little to the persistence of lynx in the DPS (68 FR 40077, 40079-80). This repeated dispersal into habitats that ultimately cannot support the species (‘‘sink’’ habitats) often leads to confusion among scientists and the public about where lynx populations may be viable (74 FR 66938).

In addition to distinguishing between historical occurrence records associated with irruptions/ dispersal and those suggesting resident lynx populations, the “mainland-island” metapopulation structure thought to govern lynx populations in the DPS (McKelvey *et al.* 2000b, pp. 25-31; see Section 2.2, above) and the transitional (and, therefore, increasingly fragmented and isolated) and spatially- and temporally-shifting nature of lynx habitat at the southern periphery of the range (Koehler and Aubry 1994, pp. 78-79; McKelvey *et al.* 2000b, pp. 29-30; 74 FR 66940; 79 FR 54814) also present challenges in defining the distribution of lynx. Both factors suggest that some areas of the contiguous U.S. may naturally support resident lynx only temporarily or occasionally when habitat conditions (both boreal forest vegetation supporting abundant hares and snow conditions favoring lynx) are adequate and/or when immigration is sufficient to offset

the lower productivity and recruitment rates expected among lynx populations in marginal or suboptimal habitats. McKelvey *et al.* (2000b, pp. 21, 29-31) described such habitats as "... source-sink mosaics that shift with disturbance and succession," and the contribution, if any, of these places (especially those that act more often as "sinks" than "sources") to the maintenance and persistence of lynx populations in the DPS remains questionable (74 FR 66938).

Finally, the southern periphery of the lynx's range, where lynx are rare in many places, overlaps with the northern distribution of the much more common bobcat; the two species are difficult to distinguish in the field, they often were not reliably differentiated in historical trapping records (McKelvey *et al.* 2000a, pp. 208-209), and errors in early accounts of lynx distribution based on anecdotal information seem likely (Halfpenny and Miller 1980, pp. 1, 3-8; Meaney 2002, pp. 3-5, Hoving *et al.* 2003, pp. 366-367; Krohn 2010, p. 33). Because of the large effect that relatively few errors in identification can have on assessments of the distribution of rare animals, especially those that are easily confused with a similar and more common species, McKelvey *et al.* (2000a, p. 209; 2008, pp. 553-554) suggest that anecdotal information should be interpreted with caution, and only verified occurrence data should be used to assess historical and current lynx distributions.

These complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with a naturally dynamic and transitional habitat, make it difficult, if not impossible, to precisely delineate the historic or current distribution of resident lynx populations in the contiguous U.S. (Koehler and Aubry 1994, p. 79; 68 FR 40084). While recognizing these limitations, we use our best professional judgment of the best scientific and commercial data available to make conclusions about the range of the lynx for the purposes of this SSA. In the following section, we descr be the types and distributions of potential lynx habitats in the contiguous U.S., and our current understanding of the historical and current distributions of resident lynx populations in the DPS considering the factors discussed above.

2.3.2.2 Lynx Distribution within the DPS Range

The southern periphery of boreal forest vegetation extends into parts of the northern contiguous U.S., where it transitions to the Acadian forest in the Northeast (Seymour and Hunter 1992, pp. 1, 3), deciduous temperate forest in the Great Lakes regions, and subalpine forest in the Rocky Mountains and Cascade Mountains in the west (Agee 2000, pp. 40-41). In much of the DPS range, these boreal forest landscapes become naturally patchy and transitional because they are at the southern edge of the boreal forest range, and they are limited, particularly in the west, by elevation and/or aspect (Ruediger *et al.* 2000, p. 4-16; 68 FR 40090). There also is increased prevalence of non-forested land uses (e.g., agriculture, development) at the southern periphery of boreal forests. These factors generally limit snowshoe hare populations in the contiguous U.S. from achieving landscape densities similar to those of the expansive northern boreal forest in Alaska and Canada, where hares are generally more abundant and more evenly distr buted across the landscape (Wolff 1980, pp. 123-128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373-375, 382, 394). Consequently, important foraging habitat for lynx is often more limited and fragmented in the

contiguous U.S. than in boreal forests of northern Canada and Alaska (Berg and Inman 2010, p. 6), and overall habitat quality is typically lower.

The habitats that lynx use in the contiguous U.S. are characterized by patchily-distr buted moist forest types with relatively higher hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with lower landscape hare densities (ILBT 2013, p.126; 78 FR 59434). In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support higher hare densities where most lynx foraging occurs. In some areas, patches of habitat containing snowshoe hares become so small and fragmented that the landscape cannot support lynx home ranges (ILBT 2013, p. 77) or populations over time (68 FR 40077). Additionally, the presence of more snowshoe hare predators and competitors at southern latitudes may inhibit the potential for high-density hare populations (Wolff 1980, p. 128). As a result, lynx generally occur at relatively low densities in the contiguous U.S. compared to the high lynx densities that occur in the boreal forest of Canada when hares are abundant (Aubry *et al.* 2000, pp. 375, 393-394) or the densities of species such as the bobcat, which is a habitat and prey generalist.

Snow conditions also determine the distribution of lynx (Ruggiero *et al.* 2000b, pp. 445-449), which are morphologically and physiologically adapted for hunting snowshoe hares and surviving in areas that have cold winters with deep, fluffy snow for extended periods. These adaptations provide lynx a competitive advantage over potential competitors, such as bobcats or coyotes (McCord and Cardoza 1982, p. 748; Buskirk *et al.* 2000a, pp. 86-95; Ruediger *et al.* 2000, pp. 1-11; Ruggiero *et al.* 2000b, pp. 445, 450), which have a higher foot load (more weight per surface area of foot), causing them to sink into the snow more than lynx. Therefore, bobcats and coyotes cannot hunt efficiently in fluffy or deep snow and are at a competitive disadvantage to lynx. Long-term snow conditions presumably limit the winter distribution of potential lynx competitors such as bobcats (McCord and Cardoza 1982, p. 748) or coyotes. These adaptations may also help lynx avoid predators such as mountain lions (Squires and Laurion 2000, p. 346), which also have higher foot-loading (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, p. 123), making them less efficient in deep and fluffy snow conditions.

Based on verified historical data, lynx occurrence has been documented in 24 states in the contiguous U.S. (McKelvey *et al.* 2000a, 207-232) and, more recently, in a 25th after some of the lynx released into southwestern Colorado dispersed into northern New Mexico (Colorado Division of Wildlife 2000, p. 3; 74 FR 66938), which had previously lacked verified evidence of lynx occurrence (USFS 2009, entire; 74 FR 66940-66943). Of these, and based on our current understanding of lynx and hare habitat requirements, the Service concludes that records in at least 11 states (Connecticut, Illinois, Indiana, Iowa, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Pennsylvania, and South Dakota) most likely represent occasional dispersing lynx that arrived in places with no historic or recent evidence of the habitat quality or quantity necessary to support a persistent resident lynx population (68 FR 40099; 74 FR 66940-66942; 79 FR 54807, 54817). These states are not within the distribution of resident lynx in the DPS, and we conclude that they naturally lack the necessary habitat, hare densities, and snow

conditions and that they were not capable historically and are not capable now of supporting resident lynx populations.

The Service originally identified the DPS as occurring in forested portions of the remaining 14 states (Colorado, Idaho, Maine, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming; 65 FR 16052, 16085). Some of these states, and parts of others, are thought to have historically supported only dispersing lynx or to have only occasionally supported resident breeding lynx (68 FR 40099; 74 FR 66940). Such areas were included within the range of the DPS because of the possibility that lynx could establish small, local populations in them and perhaps contribute to the persistence of the DPS, though evidence of this was lacking (68 FR 40080; 74 FR 66938). In its 2003 remanded determination for the lynx DPS, the Service concluded that (1) potential lynx and hare habitats in Michigan, Oregon, Utah, Vermont, and Wisconsin were relatively small, isolated, and of marginal quality, and that available information suggested that these states did not historically or recently support resident lynx populations; (2) it was uncertain whether Colorado, New York, and Wyoming historically supported resident populations or only occasional dispersers; (3) New Hampshire probably supported a small resident populations that had been extirpated; and (4) the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) had the best historic and recent evidence of resident breeding populations (68 FR 40082, 40086-40095, 40097-40101). Below we provide our current understanding of these state groupings and the information available since the 2003 remand that informs this understanding.

Michigan, Oregon, Utah, Vermont, and Wisconsin - Additional information and analysis available since 2003 support the determination that Michigan (Linden 2006, pp. 83-90) and Oregon (Aubry 2006, pp. 1-2) did not historically or recently support resident lynx populations, and no evidence has emerged suggesting that resident populations occurred historically or recently in Utah or Wisconsin (ILBT 2013, pp. 45, 58). The best available information continues to suggest that resident lynx did not historically and do not currently occur in Michigan, Oregon, Utah, and Wisconsin; that habitats in these states are naturally incapable of supporting resident breeding populations; and that historic and potential future occurrences of lynx in these states most likely represent occasional dispersing lynx. We conclude, therefore, that these states did not historically, do not currently, and in the future are very unl kely to, contr bute to the persistence and conservation of lynx in the contiguous U.S.

In contrast, nine lynx occurrences were confirmed in the 530-km^2 (205-mi^2) Nulhegan Basin of northeastern Vermont from 2003 to 2014, and breeding was confirmed in 2012; intensified surveys since then have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). This new information indicates that this small area of northernmost Vermont is at least occasionally capable of supporting a small number of resident breeding lynx, but that its ability to support a persistent resident population over time remains doubtful. Based on assessments of the amount and quality of potential lynx and hare habitat, snow conditions, and the presence and distribution of lynx competitors and predators (Hoving *et al.* 2005, pp. 746-749; Bernier 2015, entire), we conclude it is unlikely that northern Vermont can support a persistent resident lynx population (79 FR 54820-54821); that it only occasionally

supports lynx reproduction when hare abundance and snow conditions are temporarily adequate; that it most likely represents a “sink” rather than a “source” for the regional lynx population, and that this likely represents its natural historical condition.

Colorado, New York, and Wyoming - When the Service listed the DPS in 2000, it believed that a resident lynx population occurred historically in the Southern Rocky Mountains of western Colorado and southeastern Wyoming, that lynx were also historically resident in northwestern Wyoming (part of the Northern Rocky Mountains), and that the Adirondack Mountains of northern New York may historically have supported a resident population that was by then extirpated (65 FR 16055-16056; 16058-16059). In the 2003 remand, the Service noted inconsistencies and l kely errors in historic lynx reports for the Southern Rockies, questioned its original conclusion that Colorado historically supported an isolated resident population, and concluded that it was uncertain whether a resident population occurred historically in Colorado or if historic records were of periodic dispersing lynx during “extremely high populations cycles” and that a resident population never existed in southeastern Wyoming (68 FR 40081, 40091). The Service also noted that in 1999 and 2000 the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) introduced 96 lynx from Canada and Alaska into southwestern Colorado (with plans to release an additional 186 lynx from 2003-2009) in an effort to reestablish a resident lynx population, that reproduction among some of the released lynx had been documented by 2003, but that it was too early to determine whether the program would be successful (68 FR 40091). In that rule, the Service also concluded that, despite evidence of reproduction in northwestern Wyoming (part of the GYA), potential habitat there is naturally marginal (patchier and composed of drier forest types), may be incapable of supporting a resident lynx population, and that lynx in northern Wyoming are most likely dispersers (68 FR 40090). Also in 2003, the Service concluded that it was poss ble resident lynx occurred in northern New York prior to 1900 but the potential habitat there is small, marginal, and likely has only supported dispersing lynx since then, and that an effort to reintroduce lynx there failed quickly, suggesting the habitat is incapable of supporting a resident population (68 FR 44486-44487).

In Colorado, after the initial release of 96 lynx in 1999 and 2000, none were released in 2001 or 2002 while protocols were evaluated and refined based on monitoring of the initially-released lynx (Shenk 2010, pp. 1, 4; Ivan *in* Lynx SSA Team 2016, p. 22). From 2003-2006, another 122 lynx were released, bringing the total to 218 (Devineau *et al.* 2010, p. 526). Reproduction was documented in 2003-2006 and 2009-2010, with 48 dens documented in that time, including a third generation of Colorado-born lynx (Shenk 2010, p. 5; Ivan *in* Lynx SSA Team 2016, p. 22). In 2010, CPW determined that all benchmarks for its lynx program had been met and had resulted in the establishment of a viable, self-sustaining lynx population (Ivan, 2011a, pp. 11, 12). Intensive monitoring of the population ceased in 2010 and was replaced by an effort to develop a minimally-invasive long-term monitoring program (Ivan 2011b, entire), which used snow-tracking surveys and camera traps to document continued lynx presence in the core release area of the San Juan Mountains in 2010-11 and again in 2014-15, with evidence of reproduction also documented during that time (CPW 2015, p.1; Ivan *in* Lynx SSA Team 2016, pp. 22-23). In its 2014 revised critical habitat designation for the DPS, the Service concluded

that the historic record of verified lynx occurrence in Colorado combined with naturally highly-fragmented and isolated potential habitat and generally low snowshoe hare densities suggest that Colorado and the Southern Rockies were unlikely to have historically supported a persistent resident lynx population and that the long-term persistence of the introduced population is uncertain (79 FR 54787-54789, 54793-54795, 54816-54817). The current size of the resident lynx population in Colorado is unknown but thought to number between 100 and 250 (Ivan *in* Lynx SSA Team 2016, p. 47). We continue to believe that available information suggests Colorado did not historically support a persistent resident lynx population and that the long-term persistence of the introduced population remains uncertain.

Information and analyses since the 2003 remand support the conclusion that New York has inadequate habitat quantity and quality (both vegetation and snow conditions) to support a resident lynx population (Hoving *et al.* 2005, pp. 746, 749). Based on Hoving *et al.* (2005) and our evaluation of the verified records of historic occurrence presented by McKelvey *et al.* (2000a, pp. 215-217), we conclude that the Adirondack Mountains of northern New York have not recently and likely did not historically support a persistent resident lynx population, are likely incapable of doing so, that verified historic records were most likely of dispersing lynx, and dispersing lynx may currently and in the future continue to occur rarely and temporarily in northern New York.

In northwestern Wyoming, additional information available since 2003 documented continued presence of a small number of lynx as recently as 2010, including some evidence of reproduction during that time, and documentation of Colorado-released lynx that dispersed into and through Wyoming (Squires *et al.* 2003, entire; Squires and Oakleaf 2005, entire; Murphy *et al.* 2006, entire; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Hanvey 2016, pers. comm.; Ivan 2016, pers. comm.; Murphy 2016, pers. comm.). However, more recent surveys and research-related trapping efforts have failed to detect lynx in this area or elsewhere in Wyoming since 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45). In the 2014 revised critical habitat designation, the Service noted:

> Although the GYA has a long history of lynx presence and recent evidence of reproduction (Squires and Laurion 2000, entire; Squires *et al.* 2001, entire; Murphy *et al.* 2006, entire), there are relatively few verified records of lynx from Yellowstone National Park and surrounding areas (65 FR 16058, 68 FR 40090). Additionally, lynx habitat in the GYA is naturally marginal (patchier and composed in many places of drier forest types), less capable of supporting snowshoe hares (Hodges *et al.* 2009, entire), and farther from source populations than most other parts of the DPS range (68 FR 40090). Given the naturally marginal habitat in this largely protected area, we believe it is unlikely that the GYA ever supported more than a handful of lynx home ranges in any given year. We find no evidence that the GYA once supported a larger or more robust lynx population than the small one suggested by verified historic and recent records and survey efforts (79 FR 54791).

We concluded that the historic record and recent evidence of lynx occupancy and reproduction suggested the presence of a small but persistent resident lynx population in the GYA of northwestern Wyoming and southwestern Montana (79 FR 54791, 54796-54797, 54825-54826); however, the consistency of occupancy over time remains uncertain (Lynx SSA Team 2016, pp. 11, 45, 57). Uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016, p. 57). If residency was intermittent historically, the current apparent absence of resident lynx might be a natural condition related to the area's largely marginal or suboptimal habitat conditions - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. In that case, future intermittent residency would be expected, but only if lynx dispersing from a source population immigrate to the GYA when habitat conditions and hare densities return to more favorable levels. Conversely, if the GYA always historically supported a small number of resident lynx but no longer does, it may suggest that some factor or factors have acted to tip the quality of the area's habitat from just barely capable of supporting a small resident population to no longer capable of doing so, resulting in extirpation. We conclude that this uncertainty cannot be resolved based on the available information but, given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its historic inability to support a robust, persistent resident population and its apparent recent inability to support any resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. We also note that extensive areas of the GYA were burned by the large, intense wildfires of 1988, and that these areas may soon (perhaps in the next 5-15 years) regenerate to a stage containing the dense horizontal conifer structure favorable for hares and, therefore, lynx foraging habitat, perhaps increasing the l kelihood that the GYA may support resident lynx again in the near future (Lynx SSA Team 2016, p. 46).

In southern Wyoming, all recent occurrences of lynx appear to be of Colorado-released lynx that moved into or through the area (see Devineau *et al.* 2010, Fig. 1, p. 526), including one female who in 2004 established a den in the Snowy Mountains and produced kittens that did not survive (Bjornlie 2016, pers, comm.; Ivan 2016, pers. comm.). Based on the available information, we conclude that southern Wyoming did not historically or recently support a resident lynx population and is not now capable of doing so.

New Hampshire - There were 18 confirmed lynx records indicating 28 individual lynx in northern New Hampshire from 2006 to 2013, with evidence of reproduction in 2010 and 2011 (79 FR 54820). An additional 8 lynx detections were documented in 2014 (Siren 2014, p. 7), 24 lynx track intercepts were recorded during snow-tracking surveys during the winter of 2014-2015 (Siren 2016, p. 1), and surveys in 2016 also detected lynx (Siren 2016, pers. comm.). Most records since 2006 are in the vicinity of Pittsburg in the northernmost reaches of the state, though lynx detections in 2015 and 2016 suggest a southern expansion from the area of 2006-2014 detections (Siren 2016, p. 1; Siren 2016, pers. comm.). Despite recent evidence of lynx

residency and reproduction, the Service concluded in the 2014 revised critical habitat designation that, based on modeling of the amount of potentially suitable habitat and favorable snow conditions (Hoving *et al.* 2005, pp. 739, 749; Litvaitis and Tash 2005, p. A-298), it is unlikely that northern New Hampshire will support a resident breeding population over the long-term (79 FR 54820-54821). Siren (2014, p. 10) suspected that the relatively few lynx detections documented in 2012-2014 may be related to the presence and abundance of bobcat, coyote, and fisher populations in northern New Hampshire. We conclude that northern and central New Hampshire likely supported a small resident lynx population historically that was extirpated during the latter half of the 20th century. We are uncertain whether lynx detections in northernmost New Hampshire over the past decade may represent the natural reestablishment of a small resident breeding population in the state or if it is a temporary phenomenon related to an expanding source population in neighboring northern Maine (79 FR 54821). Although bobcat populations have increased and expanded their range in this region in recent decades (Lavoie *et al.* 2009, pp. 873-874), severe winters and deep snow can substantially limit their populations (Reed 2009, pp. 29-33; McCord, 1974, pp. 433-434). Maine's bobcat harvest declined substantially after two deep snow winters in 2008 and 2009 (Maine Department of Inland Fisheries and Wildlife 2015, p. 37). It is possible that these anomalous deep snow winters provided a temporary competitive advantage to lynx in northern New Hampshire.

Idaho, Maine, Minnesota, Montana, and Washington - These states (along with New Hampshire, above) have the strongest historical evidence of continuous lynx presence and recent evidence of resident lynx populations (McKelvey *et al.* 2000a, pp. 211-228; 68 FR 40086-40095, 40097-40101; McKelvey *in* Lynx SSA Team 2016, p. 11). Historic lynx records exist for much of Idaho, but many, especially in the central and southern part of the state, occurred in anomalous habitats or were associated with large irruptions of lynx from Canada to the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 225-227). The historic record and recent surveys (summarized at 79 FR 54818-54820; also see U.S. District Court ID 2016, pp. 18-24) suggest that only dispersing lynx occur throughout most of Idaho, habitats in many parts of the state are drier forest types that support lower densities of hares, and resident lynx seem to be confined to the Purcell, Selkirk, and possibly the Cabinet mountain ranges in the northern panhandle. The number of resident lynx in northern Idaho is unknown but certainly small based on the amount of potential habitat, and resident lynx here are part of a larger population that occurs primarily in northwestern Montana and southeastern British Columbia.

Maine has a long history of continual lynx presence, with evidence of a persistent resident population in much of the northern half of the state, which currently supports the largest lynx population in the DPS (Krohn 2010, entire; McKelvey *et al.* 2000a, pp. 211-212; Hoving *et al.* 2003, entire; Vashon *et al.* 2012, pp. 50-60; 79 FR 54784-54785, 54792, 54822-54824; Vashon *in* Lynx SSA Team 2016, p. 18). The lynx population in Maine is much larger than was suspected at the time of listing or the 2003 remand (potential habitat exists to support possibly 750-1,000+ individuals [Vashon *in* Lynx SSA Team 2016, p. 18], though a reliable population estimate is lacking). The current abundance of lynx is supported by the broad distribution of high-quality hare habitat that resulted from extensive, large-scale clearcutting in the 1970s and

1980s in response to a massive spruce budworm outbreak (68 FR 40087; 79 FR 54792; also see section 4.1.1, below). As these regenerating clearcuts, which currently provide the dense horizontal structure preferred by hares, mature beyond about 35 years post-harvest, hare densities decline as cover and forage are reduced due to forest succession (Simons 2009, p. 217). The current lynx population is probably larger than the likely historic condition, when relatively small amounts of the spruce-fir forests in the state are thought to have been composed of young stands (Lorimer 1977, entire; 68 FR 40094; Vashon *et al.* 2012, pp. 45, 56; 79 FR 54792). With the reduction in clearcutting following enactment of the Maine Forest Practices Act of 1989, it is projected that lynx densities in Maine will decline by 55 to 65 percent by 2032 (Simons 2009, p. 217). Lynx in Maine likely represent the southern periphery of a larger population that occurs in northern New Brunswick and southern Quebec south of the St. Lawrence Seaway/River, which appears to partially isolate lynx in this region, demographically and genetically, from populations in the core of the species' range (Koen *et al.* 2015, entire). The extent to which lynx persistence in Maine relies on immigration from Canada is unknown.

In Minnesota, research conducted since the 2003 remand has demonstrated the continuous presence of a resident lynx population in the northeastern part of the state that seems to be the southern periphery of a larger population in southwestern Ontario (Moen *in* Lynx SSA Team 2016, pp. 19, 39). The number of resident lynx in Minnesota is unknown but believed to be between 50 and 200 (Moen *in* Lynx SSA Team 2016, pp. 19, 39). Lynx are occasionally detected in other parts of the state, but hare densities and snow conditions consistently favorable for lynx appear to be restricted to the northeastern "Arrowhead" region of the state, and areas to the south and west are dominated by bobcats. Although there are currently more lynx in Minnesota than suspected at the time of listing, it is unclear whether current numbers and distr bution are similar to the historical condition. The extent to which lynx persistence in Minnesota relies on immigration from Canada is also unknown.

In Montana, research conducted since the DPS was proposed for listing has documented the continued presence and broad distribution of resident lynx in much of the northwestern portion of the state (Squires *in* Lynx SSA Team 2016, p. 20). The number of resident lynx in northwest Montana is unknown but believed to be between 200 and 300 (Squires *in* Lynx SSA Team 2016, p. 41) in three subpopulations - the Purcell Mountains, Seeley Lake/Central, and Garnet Mountains subpopulations (Squires *in* Lynx SSA Team 2016, p. 20). Recent (2014-2015) surveys failed to detect lynx in the Garnet Mountains in the southern part of the area (Squires *in* Lynx SSA Team 2016, p. 20), which had residents as recently as 2010 and is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.). Lynx in northwestern Montana (and northern Idaho) likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia. The extent to which lynx persistence in this area relies on immigration from Canada is unknown, and there is no indication of substantial immigration from Canada after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). In southwest Montana, few lynx and no recent evidence of reproduction have been documented in the Montana portion of the GYA where, as with the northwestern Wyoming part of the GYA (discussed above), uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent

apparent absence from the area (Lynx SSA Team 2016, p. 57). As elsewhere in the West, recent research and habitat assessments suggest that habitats capable of supporting resident lynx in Montana are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12).

In Washington, research and monitoring conducted since the 2003 remand has continued to document a resident lynx population in the Okanogan region of the eastern Cascade Mountains in the north-central part of the state (von Kienast 2003, entire; Maletzke 2004, entire; Koehler *et al.* 2008, entire; Maletzke *et al.* 2008, entire; Maletzke *in* Lynx SSA 2016, pp. 21-22). Since at least 1985, this is the only area of the state with evidence of a resident breeding population (Koehler and Maletzke 2006, p. 4; Koehler *et al.* 2008, p. 1518; ILBT 2013, p. 58; Maletzke *in* Lynx SSA 2016, p. 21), although the Kettle Mountains in the northeastern part of the state are thought to have historically supported a small breeding population, and lynx are detected there occasionally (Stinson 2001, pp. 13–14; Koehler *et al.* 2008, p. 1523; USFWS 2008, p. 2). Multiple large fires in the Okanogan over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). Although these areas should regenerate into lynx and hare habitat, it may take 35-40 years (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and insect impacts could further diminish habitat availability and the lynx population's probability of persistence (Lynx SSA Team 2016, p. 44; see also sections 3.4, 4.1.4, and 5.1.4, below).

In summary, although uncertainty remains regarding the historic distribution of resident lynx in the DPS and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population declines in the contiguous U.S. from historical conditions until the DPS was listed have been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11). New information summarized above indicates that there are many more lynx in Maine and Minnesota than was suspected at the time of listing, and there are naturally fewer lynx and a more limited distribution of suitable habitats in the western U.S. than was previously thought (68 FR 40085, 40091-40092; ILBT 2013, p. 23). Lynx in Maine are at historically high numbers and may currently be facilitating the recolonization of formerly occupied habitat in northern New Hampshire, though lynx persistence in New Hampshire is uncertain and lynx numbers in Maine are projected to decline over the next several decades. In the West, small breeding populations in the GYA and the Garnet Mountains of Montana may recently have become extirpated (although both also may be only temporarily "winked off" in a metapopulation dynamics sense). In north-central Washington, lynx habitat and numbers have declined because of recent large fires and insect outbreaks, and the persistence of the breeding population there could be threatened if additional such impacts occur with similar magnitude and frequency over the next several decades. As a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, resident lynx currently occur in western Colorado. Although the number of lynx in this population and its future persistence are uncertain, Colorado currently

supports more lynx than it likely did, based on the historic record, for much of the previous century. The geographic units evaluated in this SSA include all areas in the contiguous U.S. with strong historical and recent evidence of persistent resident lynx populations. Detailed assessments of the current status and future viability of resident lynx populations and habitats in these areas are presented in chapters 4 and 5 below.

Chapter 3: Factors Influencing Viability of the DPS

In this chapter we discuss factors thought to influence the historic and current distribution and status of lynx populations in the contiguous U.S., their likely influence on the future viability of the DPS, and we describe the cause-and-effects pathways of impacts associated with particular factors. We focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in federal land management plans at the time of listing) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68-78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS.

3.1 Regulatory Mechanisms

A number of activities with the potential to affect lynx habitat suitability, productivity, mortality, and movements via habitat loss or fragmentation, creation of barriers, or that otherwise alter the vegetation mosaics and prey abundances maintained historically by natural disturbance processes may occur in lynx habitats regardless of land ownership and management. The extent to which regulations guide such activities to avoid, minimize, or mitigate impacts to lynx influences the current and future likelihoods that those habitats will provide the physical and biological features needed to support resident lynx populations. As described in more detail below, the lynx DPS was listed as threatened because of the lack of specific conservation direction and associated regulations on federal lands. At that time, the available information indicated that most lynx habitat in the DPS occurred on federal lands, predominantly in the western U.S. (65 FR 16061). Since then, research and monitoring have revealed that non-federal lands contribute more to the conservation of the DPS than was known at the time of listing, particularly in the Northern Maine and Northeastern Minnesota regions. Therefore, in the following sections we describe and compare the federal regulatory environment for lynx in the DPS at the time of listing and currently, and we describe other regulatory mechanisms as they pertain to lynx on private as well as State and Tr bal lands.

Since it was listed in 2000, the DPS has been protected by the ESA’s prohibition on take (under section 9), which applies to lynx wherever they occur in the DPS, regardless of land ownership. The DPS has also been protected since listing by section 7 of the ESA, which requires federal agencies to use their authorities to conserve listed species and to consult with the Service for any actions they implement, fund, or permit (i.e., for which a “federal nexus” exists) and which

may affect lynx or lynx habitats within the DPS, again regardless of land ownership. Additionally, section 4 of the ESA requires that critical habitat, defined as the specific geographic areas containing the physical and biological features essential for the conservation of a listed species and that may require special management and protection, be designated for listed species, and section 7 prohibits the destruction or adverse modification of such designated habitats. Critical habitat was designated for the lynx DPS in 2007 and was revised in 2009 and 2014. Section 4 also requires recovery planning for listed species; a recovery plan for the lynx DPS has not yet been completed, but part of the purpose of this SSA is to inform near-term recovery planning direction.

3.1.1 Federal Regulatory Mechanisms

Federal lands make up approximately 64 percent of the lands encompassed by the six geographic units evaluated in this SSA. Of those federal lands, roughly 87 percent is managed by the U.S. Forest Service (USFS), 11 percent by the National Park Service (NPS), and 2 percent by the Bureau of Land Management (BLM). The amount of federal land varies by unit, ranging from 0 percent in the Northern Maine Unit to over 97 percent in the GYA Unit (see Table 1, above, and Chapter 4, below, for ownership in each geographic unit). Federal lands management is guided by a number of statutes and associated regulations, policies, standards, guidelines, and best management practices applied by managing agencies to meet legislative mandates and achieve agency missions (for a summary of relevant Acts and associated regulations and guidance, see USFWS 2014, pp. 24-34). Many of these regulatory mechanisms provide some benefits to lynx and protect lynx habitats (USFWS 2014, pp. 24-34). For example, the conservation priority in the management of NPS lands in accordance with the National Park Service Organic Act (16 USC 1 et seq. as amended), the National Parks and Recreation Act (Public Law 95-625), and the Wilderness Act (16 USC 1131-1136, 78 Stat. 890) likely provides an adequate regulatory framework for the conservation of lynx populations and habitats in the NPS units in which they occur (USFWS 2014, pp. 28-29, 31-33). However, it was the absence of specific management direction and conservation measures for lynx and lynx habitats in USFS and BLM land management plans that led the Service to conclude that the regulatory mechanisms in those plans at the time of listing were inadequate to provide for the conservation of the DPS. Therefore, the evaluation below focuses on the efforts of USFS and BLM, in collaboration with the Service, to address the regulatory inadequacy for which the DPS was listed.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx populations and potential lynx habitats (broad forest vegetation classes defined as “lynx forest types” [65 FR 16071]) in the contiguous U.S. occurred on federal (USFS, NPS, and BLM) lands in the western states, and that the plans that guided management of those lands (particularly USFS and BLM lands) included “...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species” (65 FR 16052, 16082). At that

time, the Service found that USFS and BLM management plans did not adequately address risks to lynx and, as identified in the LCAS (Ruediger *et al.* 2000, pp. 2-1 through 6-3), those plans allowed actions that cumulatively could result in significant detrimental effects to lynx in the contiguous U.S. As a result, the Service concluded in the final rule that the lack of federal Land Management Plan guidance for the conservation of lynx and the potential for those plans to allow or direct actions that could adversely affect lynx constituted a significant threat to the DPS (68 FR 40096).

In 1998, in anticipation of the DPS's listing under the ESA, regional and state directors of the Service, USFS, BLM, and NPS approved preparation of the interagency LCAS to provide a consistent and effective approach to conserve lynx and to assist with Section 7 consultation on federal lands. An interagency Steering Committee selected a Science Team to assemble the best available scientific information on lynx and appointed the ILBT to prepare a lynx conservation strategy applicable to federal land management in the contiguous U.S. (USFWS 2014, p. 15). The first edition of the LCAS was completed in January, 2000 and revised in August, 2000 (Ruediger *et al.* 2000, entire). The Steering Committee subsequently issued several amendments and clarifications, and the most recent revision of the LCAS was completed in August, 2013 (ILBT 2013, entire). The LCAS initially identified and evaluated 17 risk factors (e.g., timber and fire management, recreation, roads, livestock grazing, trapping, etc.) thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements, and that may be addressed under programs, practices, and activities within the authority and jurisdiction of federal land management agencies. These risk factors included programs or practices with the potential to result in habitat conversion, habitat fragmentation, or obstruction to lynx movement; roads or winter recreation trails that may facilitate access to historical lynx habitat by competitors; and fire suppression, which changes the vegetation mosaic maintained by natural disturbance processes. The risks identified in the 2000 LCAS were based on potential effects to lynx habitats and to individual lynx, lynx populations, or both; therefore, not all of the risks initially identified in the LCAS were thought to threaten lynx populations in the DPS (68 FR 40096). In the 2013 revised LCAS, risk factors were redefined as "Anthropogenic Influences on Lynx and Lynx Habitat," and grouped into two tiers based on the potential magnitude of effects (ILBT 2013, pp. 1, 68). First tier influences (climate change, vegetation management, wildland fire management, and habitat fragmentation - discussed in the remainder of this chapter, below) are those with potential to negatively affect lynx populations and habitats, while second tier influences are those that may affect individual lynx but are not expected to substantially impact populations or habitats (ILBT 2013, pp. 68-85).

In addition to identifying risks, the LCAS also directed federal agencies to map potential lynx habitat and identify lynx analysis units (LAUs) to evaluate potential impacts of management actions on lynx and snowshoe hare habitats. Finally, the LCAS developed recommended conservation measures, standards, and guidelines to be applied to lynx habitats on federal lands that were designed to mimic historic conditions and landscape-scale disturbance patterns and to maintain or improve lynx and hare habitats at both local (project-level) and landscape scales (USFWS 2014, p. 16). After its initial completion in 2000, USFS and BLM managers within the range of the DPS agreed to implement the standards and guidelines identified in the

LCAS until management plans could be formally amended to specifically address lynx conservation. In 2000, the Service, USFS, and BLM developed and adopted Canada Lynx Conservation Agreements (CAs; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire) in which the BLM and USFS agreed to coordinate assessment and planning efforts with the Service to assure a comprehensive approach to lynx conservation and to use the LCAS, supporting science, and locally specific information as the basis for the approach and to streamline consultation under section 7 of the ESA. The USFS further committed to deferring any actions not involving third parties that would adversely affect lynx until such time as the Forest Plans were amended or revised to adequately conserve lynx (USFS and USFWS 2000, p. 8; 68 FR 40083).

Concurrent with development of the LCAS and interagency CAs, the USFS and BLM in 1999 completed the *Biological Assessment* (BA) *of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx* (USFS and BLM 1999, entire). The BA identified and evaluated the potential effects to lynx of implementation of 57 USFS Land and Resource Management Plans and 56 BLM Land Use Plans throughout the 14 states in which the lynx DPS was proposed for listing. The BA concluded that the potential for adverse effects to lynx existed on each administrative unit in each geographic area and that, cumulatively, implementation of the existing plans was likely to adversely affect the DPS. It recommended that all of the plans be amended or revised to incorporate conservation measures to reduce or eliminate adverse effects to lynx (USFS and BLM 1999, p. 14). In its 2000 biological opinion on the BA, the Service evaluated the USFS and BLM plans in conjunction with the CAs described above (USFWS 2000, p. 15). The Service concluded that implementation of the existing plans in accordance with the CAs until plans could be formally amended or revised was not likely to jeopardize the DPS, but that amendments or revisions to those plans were needed to further reduce or avoid the potential for adverse effects to lynx (USFWS 2000, pp. 48-50).

In the 2003 remanded rule, the Service similarly determined that adherence to the CAs, the biological opinion, and the LCAS in assessing the impacts of federal actions on lynx alleviated the effects of federal land management activities on lynx, but that amendment of USFS and BLM land management plans to conserve lynx would be the strongest mechanism to ensure long-term conservation of lynx and lynx habitat on federal lands (68 FR 40096-97). It concluded that although federal, State, and Tribal regulations and plans had reduced threats to the DPS, the inadequacy of existing regulatory mechanisms still posed a moderate, albeit lower-level threat, and would continue to do so until federal land management plans were specifically amended to address lynx conservation (68 FR 40097).

Since the 2003 remand, most Forest Service units with lynx forest types have formally amended or revised their land management plans to incorporate the conservation measures, standards, and guidelines identified in the LCAS. From 2004-2006, forest plans for seven national forests with potential lynx habitat in Maine, New Hampshire, Vermont, Michigan, Minnesota, and Wisconsin were revised to include recommendations from the LCAS and the CAs (Jackson 2015, pers. comm.; USFWS 2104, p. 33). In 2007, the USFS completed the Northern Rockies

Lynx Management Direction (NRLMD), which formally amended management plans to include lynx conservation measures, standards, and guidelines for 18 national forests covering over 150,000 km^2 (57,915 mi^2) in Idaho, Montana, Wyoming and Utah, including over 72,000 km^2 (27,800 mi^2) of potential lynx habitat (USFS 2007, entire; USFWS 2014, pp. 16-19; 79 FR 54813; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). In 2008, USFS similarly completed the Southern Rockies Lynx Amendment (SRLA), which formally amended forest plans covering about 59,000 km^2 (22,780 mi^2), including over 30,000 km^2 (11,583 mi^2) of mapped (potential) lynx habitat on 7 national forests or national forest complexes in western Colorado and southern Wyoming (USFS 2008, entire; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). The management direction adopted in the Northern and Southern Rockies amendments was developed in accordance with the National Forest Management Act of 1976 and the regulations that implement the statute (36 CFR 219.22), which requires public review and comment as part of the decision making process. Among national forests within the geographic units evaluated in this SSA, only those in Washington (the Okanogan-Wenatchee and Colville national forests) have not formally amended or revised their land and resource management plans. However, the plan revision process has been initiated for both forests, and both continue to manage for lynx habitats in accordance with the LCAS and the CA.

BLM lands account for just over 1 percent of the total area within the SSA geographic units, and most occur in Colorado, Montana, and Wyoming (Table 1, above). In the Western Colorado SSA unit, BLM Field Offices that contain potential lynx habitat include the Colorado River Valley, Grand Junction, Gunnison, Kremmling, Little Snake, Royal Gorge, San Luis Valley, Tres Rios, Uncompahgre, and White River Field Offices. These BLM areas were subject to the 2000 interagency CA; however, that CA expired in 2004 (BLM and USFWS 2000, p. 8) and was not renewed. Since then, BLM Resource Management Plans (RMPs) have been revised on the Colorado River Valley, Grand Junction, Kremmling, Little Snake, and Tres Rios Field Offices. RMPs for the Gunnison, Royal Gorge, San Luis Valley, Uncompahgre, and White River Field Offices have not been revised and do not contain specific measures for the conservation of lynx. BLM lands in the Garnet Resource Area in Montana and parts of the Kemmerer and Pinedale districts in Wyoming occur within the Northwestern Montana/Northeastern Idaho and GYA SSA geographic areas, respectively. These areas were also designated as lynx critical habitat. The RMP for the Garnet area was amended in 2004 to formally adopt the conservation measures of the LCAS (BLM 2004a, 2004b, entire), and the RMPs for the Pinedale and Kemmerer districts were revised in 2008 and 2010, respectively, to adopt conservation measures and best management practices for lynx (BLM 2008b, pp. A18-10 - A18-16; BLM 2010b, pp. A-9 - A-12).

The completion and implementation of the LCAS, the interagency CAs, and the subsequent formal management plan revisions and amendments all were undertaken to address the inadequacy of regulatory mechanisms on USFS and BLM lands for which the DPS was listed. Each incorporated the best available scientific information to develop goals, objectives, conservation measures, standards, and best management practices (BMPs) to guide USFS and BLM management activities at both project- and landscape-level scales to reduce or eliminate the potential for adverse effects to lynx or its habitats and thus promote the conservation of the DPS (Ruediger *et al.* 2000, pp. 7-1 - 7-18; BLM and USFWS 2000, entire; USFS and USFWS

2000, entire; USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). Standards and guidelines developed and implemented in accordance with the NRLMD and the SRLA were designed to limit potentially adverse effects and promote beneficial effects of management activities (vegetation management [e.g., timber harvest, precommercial thinning], wildland fire and fuels management, grazing, recreation, road/access management, energy development, etc.) on important lynx habitats including winter snowshoe hare habitat (high-quality lynx foraging habitat), denning habitat, and linkage/connectivity corridors (USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). The USFS concluded that the vegetation standards adopted in the NRLMD that limit the total amount and the rate at which lynx habitat can be converted to temporarily unsuitable habitat (stand initiation seral stage following timber harvest) ensure that the agency's timber management program is beneficial to lynx and will provide sufficient lynx habitat through time at both LAU and landscape-level scales (USFS 2007, p. 35). In its biological opinion on the NRLMD, the Service concluded that its application "...would substantially reduce or eliminate adverse effects to lynx from Forest Service land management activities on at least 94 percent of this area, and more likely nearer to 98 percent" (USFWS 2000, p. 76). Similarly, in its 2008 biological opinion on the SRLA, the Service concluded that vegetation management standards in the SRLA would proh bit treatments that could adversely affect essential components of lynx habitat on 95.5 percent of the mapped (potential) lynx habitat in the SRLA area (USFWS 2008, p. 52).

In summary, all USFS and some BLM lands with known or potential lynx habitat within the range of the DPS, including all SSA geographic units, are currently managed in accordance with the specific conservation measures and considerations identified in the LCAS and implemented via the CAs or formally revised and amended management plans described above. These agreements and revised/amended plans constitute the regulatory framework and specific regulatory mechanisms adopted to conserve lynx habitats and populations on USFS and BLM lands that support or are capable of supporting them. They represent the agencies' efforts, in collaboration with the Service, to address and ameliorate the singular threat for which the lynx DPS was listed under the ESA. Although formal effectiveness monitoring has not been completed, it's clear that implementation of the CAs and revised/amended plans, and the associated programmatic and project-specific consultations between BLM/USFS and the Service in accordance with section 7 of the ESA, have resulted in avoidance/minimization of impacts to important lynx and hare habitats on federal lands and have reduced the likelihood that management activities on these lands may adversely affect lynx in the contiguous U.S.

3.1.2 State Regulations and Tribal Management

Private, State, and Tribal lands make up the remaining 36 percent of the lands encompassed by the six geographic units evaluated in this SSA, accounting for almost 27 percent, almost 9 percent, and 1 percent of the total, respectively (Table 1). The amount of private land varies by unit, ranging from 0.3 percent in the North-central Washington Unit to almost 92 percent in the Northern Maine Unit. Likewise, State ownership varies from less than 1 percent in the GYA and Western Colorado units to 36 percent in the Northeastern Minnesota Unit. Tr bal lands account for about 4 percent of the Northwestern Montana/Northeastern Idaho Unit and roughly 1 percent

of the Northern Maine and Northeastern Minnesota units; there are no Tr bal lands in the North-central Washington, GYA, or Western Colorado units. Private, State, and Tribal lands, combined, constitute all of the lands in the Northern Maine Geographic Unit and over half of those in the Northeastern Minnesota Unit. Because both of these units support larger resident lynx populations than was known when the DPS was listed and, therefore, may contribute more substantially to the conservation of the DPS than was understood at the time of listing, we must evaluate the regulatory mechanisms that pertain to lynx on these lands (Lynx SSA Team 2016, p. 54). Although private, State, and Tribal lands constitute much smaller proportions of the other four (western) geographic units (from about 3 percent to 16 percent, combined), important lynx habitats occur on some of those lands, and regulatory mechanisms may influence their contributions to the conservation and persistence of DPS populations or parts of them. Therefore, in this section, we summarize the relevant regulatory frameworks and mechanisms that may affect lynx on private, State, and Tribal lands within the six geographic units of the DPS, but with a focus on those units with the greatest proportions of these lands and on activities on these lands with the greatest potential to impact lynx.

State Wildlife Management Regulations - The following information is derived from the Service's 2014 Incremental Effects Memorandum prepared in support of the revised designation of critical habitat for the lynx DPS (USFWS 2014, pp. 35-38) and updated as warranted by new information. State furbearer and other wildlife management regulations benefit lynx populations in the states where they occur. In addition to State and private lands, State wildlife regulations govern hunting and trapping activities on many federal lands where those activities are permitted. Most states within the range of the lynx prohibited trapping and hunting of lynx prior to the 2000 listing of the DPS under the ESA, and those activities were prohibited in all states once the DPS was listed. All states within the lynx DPS range that allow legal bobcat harvest (1) manage in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Export Program for Appendix II Furbearer Species (USFWS 2014, pp. 25-26), (2) have distributed information to bobcat trappers and hunters on how to avoid incidental take of lynx, and (3) report all known incidences of incidental take of lynx to the Service's Division of Management Authority to assure that take does not exceed the amount permitted under the intra-agency section 7 consultation for the CITES Export Program (USFWS 2001, entire). Most states have also adopted special regulations in areas where lynx occur to minimize the potential for incidental take of lynx during legal trapping of other furbearers. These efforts benefit lynx and are expected to do so in the future with continued implementation and enforcement.

Unit 1: Northern Maine - In 1967, a bounty on lynx in Maine was repealed, and lynx were given complete protection from trapping and hunting. The Maine Department of Inland Fisheries and Wildlife (MDIFW) has adopted special trapping regulations where lynx may occur that address specifics about traps types and sets that may be used to legally harvest other furbearers and that are intended to minimize the likelihood of incidentally trapping lynx (http://www.eregulations.com/maine/hunting/lynx-protection-zone-trap-restrictions/). MDIFW also adopted and made available for download on its web page the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*, and

modified it to be more specific to Maine. MDIFW also set-up an incidental lynx capture hotline and requires that all incidentally trapped lynx be reported (http://www.maine.gov/ifw/hunting_trapping/trapping/avoid_lynx.htm, last accessed 8.08.2016), and has staff on stand-by to help immobilize, evaluate, collect tissue and/or hair samples, and release, if appropriate, any lynx reported to the hotline. This program has resulted in the release of 98 lynx from 2000 - 2015 (10 died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine (MDIFW 2014, p. 75). In 2014, the MDIFW obtained an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping in Maine. After two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx (see Other Factors in section 4.1.1 below). The regulations now require exclusion devices on killer-type traps, prohibit the use of drag sets on foothold traps, address specific trap types and sets, prohibit visual use of bait and visual attractants, swivels on chains, and require reporting of incidental captures. The trapping permit is currently being litigated in federal court. The MDIFW also is responsible for implementing the Maine Endangered Species Act (http://www.mainelegislature.org/legis/statutes/12/title12sec12803.html; MDIFW 2009, p. 9). Although the lynx is not State-listed as threatened or endangered because its population is estimated to exceed the State's listing threshold, it is considered a species of special concern (MDIFW 2011, p 2). The MDIFW works collaboratively with the Service to conduct research and monitor lynx populations and habitats, and it recommends voluntary forest management activities to promote a sustainable supply and large, connected, and widely-distributed blocks of dense, young spruce-fir stands and to conserve large blocks of unfragmented forestland in northern and western Maine (MDIFW 2011, p. 3).

Unit 2: Northeastern Minnesota - Although lynx were unprotected and had a bounty placed on them in Minnesota prior to 1965, lynx trapping and hunting have been prohibited in Minnesota since 1984 (Moen *in* Lynx SSA Team 2016, p. 19). Overlapping the Northeastern Minnesota SSA unit, the State Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ) for which it has promulgated and enforces special trapping regulations for other furbearers in lynx habitat. The MNDNR has modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (pages 52-54 at: http://files.dnr.state.mn.us/rlp/regulations/hunting/2013/full_regs.pdf). In 2015, the MNDNR issued emergency trapping rules in the LMZ mandating additional restrictions on the types of traps that may be used (MNDNR 2015, entire) to further reduce the likelihood of incidentally trapping lynx. Minnesota DNR is under a federal court order to develop an incidental take plan for lynx and plans to seek an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping. Like Maine, Minnesota has a State Endangered Species Statute (84.0895) which requires the Minnesota DNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern (State of Minnesota 2015, entire). The Statute also authorizes the DNR to adopt rules that regulate treatment of species designated as endangered and threatened. Also like Maine,

Minnesota has designated the lynx a species of special concern (MNDNR 2013, p. 2), and coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats.

Unit 3: Northwestern Montana/Northeastern Idaho - Lynx are designated as a species of concern (S3) by the State of Montana and a species of greatest conservation need (S1) by by the State of Idaho (ILBT 2013, p. 57). The harvest of lynx was prohibited in Idaho and Montana beginning in 1996 and 1999, respectively. Both States participate in the CITES Export Program for bobcats, and both have promulgated and enforce special regulations for the legal trapping of other furbearers in areas occupied by lynx. In its trapping regulations, Idaho Fish and Game (IDFG) provides information on how to distinguish between bobcats and lynx and provides guidelines to reduce injury and minimize non-target catches, including lynx (IDFG 2016, pp. 36-37). Guidelines recommend (1) a minimum 8-pound pan tension on foothold traps set for wolves, (2) specific trap types and sets for other furbearers, and (3) bait and habitat considerations when making sets. Trappers are also required to contact IDFG or local sheriff's offices to assist with the safe release of incidentally trapped lynx. In response to a lawsuit after several lynx were incidentally trapped recently in northern Idaho, the U.S. District Court for the District of Idaho ordered the State to submit "a plan to protect the lynx from future incidental takes in the Panhandle and Clearwater (northern) Regions of Idaho" (U.S. District Court ID 2016, pp. 25-26). The plan has not yet been completed and negotiations between the State and the court are ongoing (Sallabanks 2016, pers. comm.). To minimize and track the incidental capture of lynx, Montana Fish, Wildlife, and Parks (MTFWP) has promulgated an evolving set of trapping regulations and reporting requirements since the DPS was listed (MTFWP 2016, pp. 7-10), including significant changes in 2008 that reduced the reported rate of incidental lynx captures from 1.6 per year in 2000-2007 to 0.4/year in 2008-2015 (MTFWP 2016, p. 5). In 2015, the Federal District Court of Montana approved a settlement agreement reached between the State of Montana and conservation groups aimed at protecting lynx from trapping. The case is now dismissed in accordance with the agreement, which requires Montana to implement a set of reasonable restrictions on trapping in lynx habitat. Currently, these regulations identify designated lynx protection zones (LPZs) and define acceptable trapping methods for public lands within them, which (1) prohibit the use of lethal (non-relaxing) snares for bobcats, (2) specifies the types of sets and baits or attractants that may be used for marten, fisher, and other furbearers where lynx occur, (3) requires a minimum 10-pound pan tension on foothold traps set for wolves, and (4) requires that any incidentally trapped lynx must be released unharmed if possible and reported to MTFWP (MTFWP 2016, pp. 7-10). MTFWP is also responsible for implementing Montana's Nongame and Endangered Species Conservation Act (http://leg.mt.gov/bills/mca/87/5/87-5-103.htm; https://www.animallaw.info/statute/mt-endangered-species-chapter-5-wildlife-protection#87-5-107).

Unit 4: North-central Washington - Lynx harvest was prohibited in Washington in 1991, and the lynx was listed as a State threatened species in 1993 and proposed for uplisting to endangered in 2016 (Lewis 2016, pp. *iii*, 1). Under the State's Endangered Species Program, the Washington Department of Fish and Wildlife (DFW) developed a Lynx Recovery Plan (http://wdfw.wa.gov/publications/00394/) and a Status Report

(http://wdfw.wa.gov/publications/01521/), and it prepares annual reports to update population and habitat information for the species. The DFW also coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats. Additionally, the use of body-gripping traps (foot-hold, conibear, snares, etc.) for trapping other furbearers is prohibited in Washington (except for damage control or nuisance wildlife, which requires special permits). This avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

Unit 5: GYA (Southwestern Montana and Northwestern Wyoming) - See Unit 3, above, for summary of Montana's special trapping regulations to minimize incidental take of lynx. Lynx in Wyoming were offered full protection from trapping and hunting beginning in 1973, and they are designated by the State as a species of greatest conservation need (ILBT 2013, p. 57). The Wyoming Game and Fish Department (WGFD) also participates in the CITES Export Program for bobcats.

Unit 6: Western Colorado - Lynx harvest was prohibited in Colorado in 1970 and the lynx was listed as endangered in the State in 1973. Colorado participates in the CITES Export Program for bobcats, provides information to trappers and hunters on how to distinguish between lynx and bobcats, and requires immediate release of uninjured incidentally trapped lynx as well as reporting of any (uninjured, injured, or killed) incidentally trapped lynx (CPW 2015b, pp. 6-7). Colorado law prohibits the use of foothold or conibear traps and snares for trapping, which avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

State Forest Management Regulations - Timber harvest and other forest management activities on State and private lands are governed by State regulations. Because these activities have the potential for beneficial, benign, or adverse impacts to lynx habitat depending on methods, implementation, and conservation measures, State forestry regulations may influence lynx populations, particularly where substantial amounts of lynx habitat occur on State and private lands. Below, we provide an overview of the forest management regulations in the SSA geographic units and briefly discuss their potential influences on lynx habitat. Additional details on the current and likely future influences of these regulations on lynx populations are provided below in chapters 4 and 5, particularly for the Maine and Minnesota units, where State and private lands constitute the majority of lynx habitats.

Unit 1: Northern Maine - State and private lands constitute 7 percent and 92 percent, respectively, of this SSA unit, with the vast majority of private lands managed for commercial timber production. As described above in section 2.3.2.2 and in more detail below in sections 4.1.1 and 5.1.1, the current abundance of lynx in northern Maine is attr butable to the landscape-scale clear-cutting that occurred on private timber lands in the 1970s and 1980s in response to an extensive spruce budworm outbreak, which resulted in the recent unnaturally large amount of young (15 to 35 years post-harvest) regenerating forest in prime hare habitat condition. The amount and distribution of this post-clear-cut excellent hare habitat likely peaked in the late 1990s, when 20-25 percent of the forest in Maine was in an early regeneration stage - 3 to 8 times higher than historic conditions, when only 3-7 percent of stands were likely in such condition at any given time (68 FR 40094). Current timber harvest and management on State

and private lands in Maine are governed by the Maine Forest Practices Act of 1989 and administered by the Maine Forest Service within the Department of Agriculture, Conservation & Forestry to regulate the size, arrangement, regeneration, and management of clearcuts (MEDACF 2014, pp. 42-45). Under the Act, small (up to 250 acre) clear-cuts are still permitted, but require special permits. Because of this regulatory burden, the extensive clear-cutting of the past has largely been replaced by partial harvest techniques that are unlikely to maintain the current unnaturally high amount and distribution of high-quality hare habitat. The consequences of this shift in forest management on Maine's current lynx population, which is also much larger than was likely possible under the natural historic disturbance regime, are discussed below in sections 4.1.1 and 5.1.1, along with other programs that may influence private lands forest management in this unit.

In Maine, there are no long term management agreements in place on private lands to assure management of lynx. In 2006 and 2007, the Natural Resource Conservation Service (NRCS) provided funds to Maine for a pilot Healthy Forest Reserve Program (HFRP) specifically to manage for Canada lynx and American marten. Five landowners enrolled in the program, but one withdrew. The remaining four landowners were provided funding to develop lynx plans on a total of about 630,000 acres (about 10 percent of the critical habitat area). Landowners selected one or two township-sized (23,000 acre) areas within their ownerships to develop and implement a lynx management plan. Thus, about 161,000 acres within the larger area was targeted for managing lynx. All four landowners completed lynx plans using guidelines in the Service's *Canada lynx management guidelines for Maine* (McCollough 2007). NRCS contracts with the landowners last 10 years and will expire in 2016 and 2017. The HFRP described an opportunity for enrollees to apply for Safe Harbor Agreements when their contracts expired, although none have indicated an interest yet in doing so. Management plans were written for a 70-year period so some landowners may continue voluntary lynx management activities. Many private landowners in Maine are enrolled in forest certification programs; the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Both programs require landowners to protect endangered species and their habitats, but there are not specific recommendations pertaining to lynx. About 2.5 million acres in northern Maine is under conservation easement (http://web.colby.edu/stateofmaine2012/state-of-large-landscape-conservation-in-maine/ last accessed 8.18.2016), but easements require management prescriptions or commitments for Canada lynx. To our knowledge, there are no private landowners in Maine who have committed to long-term or permanent protection and creation of lynx habitat according to the Service's lynx management guidelines or LCAS.

State lands include Baxter State Park (~200,000 acres) and the various lots owned and managed by the Maine Bureau of Parks and Lands (MBPL). Most of Baxter State Park is managed as wilderness area, and lynx sightings in the Park are rare because most of the park is mature forest. MBPL integrated resource policy requires that they promote the conservation of federally listed species, but so far no lynx management plans have been developed. Mitigation for Maine Department of Inland Fisheries and Wildlife's incidental take permit for trapping requires management of 6,400 acres of lynx habitat within a 22,000-acre habitat management area on the MBPL's Seboomook Unit for a 15-year period.

Unit 2: Northeastern Minnesota - State and private lands constitute about 36 percent and 16 percent, respectively, of this SSA unit. The Minnesota Department of Natural Resources (MN DNR) Division of Forestry regulates timber harvest and management on State and private lands. Under the Sustainable Forest Resources Act of 1995 (revised most recently in 2014 [MFRC 2014a, p. 1]), the Minnesota Forest Resources Council (MFRC) has developed voluntary guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) that are intended for private and state landowners and include some general recommendations for wildlife including lynx. However, because they are voluntary, the extent to which these guidelines benefit lynx is uncertain (see sections 4.1.2 and 5.1.2 below).

Unit 3: Northwestern Montana/Northeastern Idaho - State and private lands constitute about 4 percent and 8 percent, respectively, of this SSA unit, and almost all are in Montana portion of the unit. The Montana Department of Natural Resources and Conservation (MTDNRC) administers several laws pertaining to forest practices on State and private lands. These laws are intended to protect streamside management zones, reduce fire hazards, and provide BMPs to minimize non-point source water pollution (http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices, accessed July 18, 2016). Although these laws may provide indirect benefits to lynx and other wildlife, they do not include specific measures to conserve or avoid impacts to lynx habitats. However, the MTDNRC and the Service collaborated on a multi-species habitat conservation plan (HCP) for forested State Trust lands that includes a Lynx Conservation Strategy to minimize impacts of forest management activities on lynx and describes conservation commitments that are based on recent information from lynx research in Montana (USFWS 2104, pp. 22-23; 79 FR 54835-54837). This HCP covers about 64 percent of the State lands in this SSA unit, regulates activities primarily associated with commercial forest management to conserve lynx foraging, denning, and connectivity habitats, and includes a 50-year commitment (79 FR 54835-54836). Additional details on this HCP and other programs for conserving lynx habitats on State and private lands in this unit are provided in section 4.1.3 below.

Unit 4: North-central Washington - State and private lands constitute about 8 percent and 0.3 percent, respectively, of this SSA unit.t, and most are State Trust lands in the Loomis State Forest, which accounts for all 426 km^2 (164 mi^2) of State lands in this unit. The Washington Department of Natural Resources (WADNR) administers rules guiding forest practices, such as timber harvests and road building, on State, private, and tribal forests in Washington. The Forest Practices Board, an independent state agency, adopts forest practices rules to protect water quality, fish habitat, other public resources and guide DNR's permitting process for timber harvests and other forest practices statewide. The WADNR developed a Lynx Habitat Management Plan (LHMP) for WDNR-managed lands distributed throughout north-central and northeastern Washington in areas delineated as Lynx Management Zones in the Washington State Lynx Recovery Plan (Stinson 2001; Washington DNR 2006). The WADNR LHMP guides timber harvest and other vegetation management on these lands, including the part of the Loomis State Forest that occurs in this unit, with the goal of creating and preserving quality lynx

habitat through its forest management activities. Additional information on the LHMP are provided in sections 4.1.4 and 5.1.4 below.

Unit 5: GYA - State and private lands constitute about 0.3 percent and just over 2 percent, respectively, of this SSA unit and, combined, likely have little influence on lynx population persistence. Forestry regulations for the Montana portion of this unit (26 percent) are described above. In the Wyoming portion (74 percent of the unit), the Wyoming State Forestry Division is responsible for the management of forested trust land across the state, including timber management and harvest, for long term forest health and productivity. Although the Division's programs may provide some indirect benefits to lynx, they do not include species- or habitat-specific regulations or conservations measures.

Unit 6: Western Colorado - State and private lands constitute about 0.6 percent and over 9 percent, respectively, of this SSA unit. The Colorado Department of Natural Resources and the State Division of Forestry oversee forest management activities on State and private lands in Colorado.

Tr bal Management: Tribal lands encompassed by SSA geographic units include those of the Passamaquoddy Tribe and the Penobscot Indian Nation in Maine (248 km^2 [96 mi^2] in Unit 1), Grand Portage Band of Lake Superior Chippewa in Minnesota (202 km^2 [78 mi^2] in Unit 2), and the Confederated Salish and Kootenai Tribes of the Flathead Nation - Flathead Reservation in Montana (958 km^2 [370 mi^2] in Unit 3). Tr bal management of these lands is expected to benefit lynx and lynx habitats. No tribal lands occur within SSA units 4, 5, or 6.

Unit 1: Northern Maine - Tribal lands represent less than 1 percent of this unit. The Passamaquoddy Tribe's stated environmental mission is "...to protect the environment and conserve natural resources within all Passamaquoddy lands, waters, and the air we share" (Passamaquoddy Tribe 2014, entire). That of the Penobscot Indian Nation Department of Natural Resources is "...to manage, develop and protect the Penobscot Nation's natural resources in a sustainable manner that protects and enhances the cultural integrity of the Tribe" (Penobscot Indian Nation 2014, entire). Hunting, trapping or possessing lynx are prohibited in accordance with the Penobscot Indian Nation Chapter VII Inland Fish and Game Regulations – Section 204 (Penobscot Indian Nation 2012, p. 15).

Unit 2: Northeastern Minnesota - Tribal lands of the Grand Portage Indian Reservation and the Bois Forte Indian Reservation—Vermillion Lake District represent 1 percent of this SSA unit. The Grand Portage Band of Chippewa has been actively working on lynx conservation since 2004. In October 2007, the Band hosted an international conference on lynx research and conservation where more than 50 researchers from the United States and Canada presented results of research on lynx diet, habitat, and management. Additionally, on-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire).

Unit 3: Northwestern Montana/Northeastern Idaho - Tribal lands of the Confederated Salish and Kootenai Tribes of the Flathead Nation, Flathead Reservation represent nearly 4 percent of this SSA unit. The mission statement of the Tribes' Fish, Wildlife, Recreation and Conservation Division is "...to protect and enhance the fish, wildlife, and wildland resources of the Tribes for continued use by the generations of today and tomorrow" (Confederated Salish and Kootenai Tr bes 2014a, entire). An objective of the Tribes' Tribal Wildlife Management Program Plan is to ''. . . develop and implement habitat management guidelines for Canadian lynx in coordination with the Forestry Department as specified in the Forest Management Plan'' (Confederated Salish and Kootenai Tribes. 2014b, p. 5). The Forest Management Plan states that ''Standards for lynx management and habitat protection are set forth in the Canada Lynx Conservation Assessment and Strategy. This strategy guides land management activity in lynx foraging and denning habitat. Lynx occurrence and populations will continue to be monitored on the Reservation'' (Confederated Salish and Kootenai Tribes 2000, p. 285).

In summary, a variety of State wildlife and forestry regulations and conservation efforts, along with Tr bal resource management objectives, influence activities in lynx habitats across the range of the DPS. While many of these clearly benefit lynx habitats and likely contribute to the persistence of resident populations, uncertainty remains regarding the effectiveness of some regulations and voluntary programs or measures in maintaining or restoring lynx habitats. This may be especially important with regard to timber management regulations and programs on private lands, which constitute the majority of lands in the Northern Maine geographic unit and a substantial amount of the Northeastern Minnesota unit.

3.2 Climate Change

In 2014, the International Panel on Climate Change (IPCC) released its Fifth Assessment Report, which represents the current scientific consensus on global and regional climate change and the best scientific data available in this rapidly changing field. The Fifth Assessment Report largely reaffirms the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere (IPCC 2014a, entire).

''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat

fragmentation) (IPCC 2007a, pp. 8–14, 18–19). In our analyses, we weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

The IPCC's Fifth Assessment Report concludes that the strongest and most comprehensive evidence of the impacts of climate change is in natural systems, where many species have responded by shifting their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC 2014a, p. 4). The report also concludes that projected climate change during and beyond the 21st Century will increase extinction risk for many terrestrial and freshwater species (IPCC 2014a, pp. 14–15). In North America, observed impacts attributable to climate change that may affect lynx habitats and distr bution include upslope and northward shifts in species distributions across multiple taxa, and increased wildfire activity, fire frequency and duration in boreal and subarctic conifer forests of Canada and the western U.S. (IPCC 2014a, p. 31).

At the time of listing, the Service determined there was no evidence to support global warming as a threat to lynx (65 FR 16068-16069). In the 2003 remanded determination, we concluded that the best information available at that time regarding the potential impact of climate change on lynx (warming leading to long-term reductions in snow depths needed to support lynx in the eastern U.S. and eastern Canada south of the St. Lawrence Seaway; Hoving 2001, pp. 72-75) was speculative and did not demonstrate a threat to lynx (68 FR 40083, 40098). In the 2005 recovery outline for the DPS, the Service acknowledged that continued climate warming was l kely to negatively affect the boreal forest ecosystem for which lynx are highly adapted, eventually causing it to recede north and/or to higher, colder elevations, potentially resulting in a substantial reduction or even elimination of lynx habitats from the contiguous U.S. (USFWS 2005, pp. 11, 14). In the 2009 critical habitat rule, the Service acknowledged that new science concerning climate change was available, and that climate change may pose a risk to the future conservation of lynx (74 FR 8617, 8621). In the 2014 revised critical habitat rule, we concluded that recent information on regional climate changes and potential effects to lynx habitat (e.g., Knowles *et al.* 2006, pp. 4545–4559; Carroll 2007, pp. 1098–1102; Danby and Hik 2007, pp. 358–359; Gonzalez *et al.* 2007, entire; Iverson *et al.* 2008, pp. 390–400; Beckage *et al.* 2008, entire; Burns *et al.* 2009, p. 31; Johnston *et al.* 2012, pp. 6–13) suggested that climate change is likely to be a significant issue of concern for the future conservation of the lynx DPS (79 FR 54811). Specifically, climate models project reductions in the extent of boreal forest habitats and snow conditions needed to support lynx throughout the DPS, with both features modeled to migrate to higher elevations (in locations where this is possible) and northward in latitude. This would result in fewer, smaller, and more fragmented and isolated areas capable of supporting resident lynx and, therefore, smaller and more isolated lynx populations that would likely be more vulnerable to stochastic environmental and demographic events (79 FR 54811). Climate change also may have synergistic effects with other stressors (e.g., forest insect outbreaks and wildfire frequency, size, and intensity) that could further reduce and isolate lynx populations within the DPS and reduce connectivity to lynx in Canada.

Lynx biologists identify climate change as the most important and overarching factor influencing resiliency of the DPS (Lynx SSA Team 2016, pp. 14, 17, 19, 21-22, 35-47, 50, 53-57; ILBT

2013, pp. 43, 48, 53, 55, 63, 66, 69-71, 98). Climate change is likely to be exacerbated at the southern edge of the range where habitat and snow conditions are patchy and becoming increasingly marginal for the continued existence of lynx (Gonzales *et al.* 2007, p. 8). Across North America, a significant increase in proportion of winter precipitation falling as rain rather than snow has resulted in reduced persistence of the winter snowpack (Dyer and Mote 2006, entire), increased snow density (Hodgkins and Dudley 2006, entire), and decrease in the extent of deeper snowpacks (Dyer and Mote 2006 p. 1, Brown 2000, pp. 2347-2354). Climate change models suggest that future snow cover in the contiguous U.S. will be further reduced in extent and distr bution (McKelvey *et al.* 2011, pp. 2892-2896).

Warming and more frequent winter thaws are contributing to changes in snowpack structure, namely replacing deep, fluffy snow with harder, crustier snow, with these conditions occurring at higher latitudes (Callaghan *et al.* 2011, entire) and higher elevations in the Rockies (Abatzoglou 2011, pp. 1138-1141). The frequency of warm spells is correlated to the hardness of the snow surface, sinking depth, and the hunting efficiency of lynx (Stenseth *et al.* 2004, p. 10633). As the climate warms, winter temperatures are rising above freezing more often. This results in more rain on snow events and winter thaws that change the structure of the snowpack; larger grain size, basal ice layers, depth hoar (weak layers in the snowpack), and slip planes (crusts and ice layers within the snowpack) (Callaghan *et al.* 2011, p. 23). Hard snow surfaces (crust) and other structure in the snowpack are believed to reduce the competitive advantage of lynx over bobcats and other mesocarnivore competitors and predators.

Although it is believed that high elevation areas in the West may provide refugia for lynx (Lynx SSA Team 2016, p. 45), these areas will also be affected. Mountainous regions in the western U.S. have historically been strongly snow dominated from November through March. By 2050, the length of snowfall-conducive temperatures over many western mountain ranges will be reduced from approximately five (November–March) to approximately three (December-February) months of the year (Klos *et al.* 2014, p. 4566). Many relatively large areas that contain lower relief, mid-elevation mountain ranges will likely shift relatively quickly into new precipitation phase regimes (e.g., the Northern Rockies, North Cascades)(Klos *et al.* 2014, p. 4566). The interior northwestern U.S. shows a greater sensitivity of its strongly snow-dominated areas to warming because much of the region is characterized by relatively warm winter temperatures and by mainly mid-elevation mountain ranges. The climatic rain-snow transition zone will move up in altitude and latitude.

It is possible that in high elevation areas of DPS in the West, snow conditions suitable for lynx may move up slope at a faster rate than boreal forest habitat will migrate, providing a mismatch of these important habitat elements for lynx. During prehistoric periods of warmer climate, the alpine treeline ecotone (upper elevation of lynx boreal habitat) and deciduous-boreal forest ecotone (lower elevation of lynx boreal habitat) have readily moved upslope in both the northern (Kearney and Luckman 1983) and southern Rockies (Legg and Baker 1980). Boreal treelines in Scandinavia moved upslope an average of 40 m (but up to 100 m) during a recent 50-year period of warming (Kullman 1990). However, despite recent warming, the alpine treeline in North America has thus far remained relatively static (Butler *et al.* 1994). Upslope migration of

the treeline of boreal forest may be limited by high winds, desiccation, and soil depth not conducive to colonization by conifers and will occur either gradually or as a series of scattered, rapid advances as thresholds are crossed (Kupfer and Cairns 1996, p. 259-261). At lower elevations, the upslope movement of the deciduous-boreal ecotone is limited by an isocline of excessively cold winter temperatures (generally -40C), moisture (cloud, fog line), and acidic soils (Kupfer and Cairns 1996, p. 263-264). The rate that boreal forest will retreat upslope is highly speculative depending on how climate change will affect complex moisture and temperature regimes, and there could be a lag time before these community types move up slope (Kupfer and Cairns 1996, p. 268). In the Yukon, upslope migration of spruce-fir seemed to be triggered by climate thresholds and was characterized by slow, gradual change followed by rapid advances (Danby and Hik 2007, p. 361). However, in Vermont, the northern hardwood-boreal ecotone moved upslope 91 to 119 m between 1962 and 2005 consistent with rapidly increasing cloud ceilings in the Northeast, which is believed to be closely associated with this ecotone transition (Beckage *et al.* 2008, pp. 4200-4201).

In contrast, there have been no lag time or thresholds slowing changes in the precipitation and snow regime. Much of the Rockies have already experienced declines in spring snowpack in response to climate change, especially since midcentury, despite increases in winter precipitation in many places (Mote *et al.* 2005, entire; Scalzitti *et al.* 2016, pp. 5367-5368). Some mountainous regions are warming at a faster rate than global land averages (Rangwalla and Miller 2012, entire). It is likely that the losses in snowpack observed to date will continue and even accelerate (Hamlet and Lettenmaier 1999; Payne *et al.* 2004), with faster losses in milder climates like the Cascades and the slowest losses in the high peaks of the northern Rockies and southern Sierras. For every 1 °C increase in temperature, snowline increases about 150 m in elevation (Beniston 2016, p. 106). By 2100, the altitude above which it snows and below which it rains will climb as much as 800 feet in the Colorado Rockies, by 1,400 feet in the Rockies of Idaho and Wyoming, and the snow line will rise by an average of 950 feet across six Western mountain regions if greenhouse gas emissions continue at the current rate (Scalzitti *et al.* 2016, p. 1564). Thus, it is possible that boreal forest will persist for a while, but deep, fluffy snow conditions will retreat upslope and preclude the use of boreal habitat by lynx and instead favor competitors such as bobcats.

The effects of climate warming are already occurring and have accelerated over the past three to four decades (Hansen *et al.* 2006, entire). Globally, greenhouse gas emissions are increasing and tracking levels predicted by models for high emissions scenarios (e.g., RCP8.5) (Peters *et al.* 2013; Friedlingstein *et al.* 2014, p. 709, 712; Fuss *et al.* 2014, p. 851; IPCC 2013, p. 180, 187-189). Analysis of paleoclimate indicates 20th century warming is likely to have been the largest of any century within the last 1000 years (Folland *et al.* 2001, pp. 99-101). These changes are predicted to continue and accelerate under future climate scenarios (Hall and Fagre 2003, Fig. 7). The range of warming projected over this century runs from 3.6 °F (2 °C) to 10.8 °F (6 °C) for North America, with warming higher than this average in areas that are inland, northerly, or mountainous.

Climate change is manifested in different ways throughout the northern contiguous United States and the lynx DPS. To date, the observed and predicted increases in surface temperatures have been greatest in the northern Rockies and Northeast (much of the lynx DPS) than elsewhere in the contiguous United States (IPCC 2014, pp. 12, 61, Workshop Report 2016, pp. 14-15). Climate history and projections from regional climate models for regions associated with the lynx DPS units corroborate global models, and indicate that both eastern and western North America, including all portions of the lynx DPS, have warmed in the last century and are l kely to warm 1.8 °F (1 °C) to 5.4 °F (3 °C) by the year 2050 (IPCC 2007b, p. 889). For example, in the Northern Rocky Mountains at Glacier National Park, mean summer temperatures have increased 3.0 °F (1.66 °C) between 1910 and 1980 (Hall and Fagre 2003, pp. 134–137) resulting in lower snowpack, earlier spring melt, and distr butional shifts in vegetation (Hall and Fagre 2003, pp. 138–139; Fagre 2005, pp. 4–9).

Climate change is diminishing snow conditions (reduced depth, quality, persistence) considerably throughout the DPS. The strong warming in recent decades corresponded to a large decline in snow cover in North America, particularly in the mountains of the western U.S. (Mote *et al.* 2005, p. 47-48). In most mountain ranges, relative declines vary from minimal at ridgetop to substantial at snow line. Temperature has increased more in the winter than summer (Knowles *et al.* 2006), which has increased the amount of winter precipitation falling as rain instead of snow throughout the DPS (Feng and Hu 2007, entire; Knowles *et al.* 2006, entire, Huntington *et al.* 2004, entire). The rate of decline in the snowpack of the northern Rockies is unprecedented in the last 1000 years (Pederson *et al.* 2011, entire). An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13).

Climate change is expected to substantially reduce the amount and quality of lynx habitat in the contiguous U.S., with patches of high-quality boreal and subalpine forest habitat becoming smaller, more fragmented, and more isolated (Carroll 2007, pp. 1099–1100; Johnston *et al.* 2012, p. 11). Various forms of snow compaction and structure within the snowpack (see above) give a competitive advantage to bobcats and other predators/competitors with higher foot loading that would normally have difficulty traveling and hunting efficiently in deep, fluffy snow conditions (Murray and Boutin 1991, Murray *et al.* 1994, Kolbe *et al.* 2010). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103). These trends indicate the range of the lynx in the DPS is likely to contract as a direct result of climate change. Because of climate change and other stressors, lynx biologists believed that only one to three of the six units may persist to the end of the century (Lynx SSA Team 2016, p. 48).

Near-term effects of climate warming on lynx are more certain than long-term effects. Lynx experts anticipate a downward trend for the probability of persistence of lynx in all six geographic units primarily because of the effects of climate warming (Lynx SSA Team 2016, pp. 35-47). The rates of change and magnitude of effects of climate warming is difficult to predict. Climate change is anticipated to affect each unit differently as summarized below.

Climate change is affecting many of the requirements necessary for the continued existence of lynx in the DPS. Climate warming will continue to stress populations into the foreseeable future. Direct effects to lynx, hares, and their habitat that are occurring or can be reasonably anticipated include 1) range contraction, 2) reduction in the periodicity and amplitude of the hare cycle, 3) reduction in snow conditions necessary to give lynx a competitive advantage, 4) reduction in hare habitat quality and populations, 5) reduction in the amount of lynx and hare habitat in the U.S., 6) changes in the frequency and pattern of disturbance events, 7) introduction of disease and parasites, and 8) reduced gene flow. Synergistic effects between these factors and other stressors (e.g., forest management, trapping, development) may intensify their effects (Carroll 2007). Diminished snow, increasing drought and fire, and increased forest pests and disease are believed to currently be the most important stressors for lynx in the DPS, but it is possible that other pathways are, or may become, equally important. Over the next decades, southern lynx populations will continue to be affected by climate change and associated shifts in habitat, prey base, and competition. The extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in the contiguous U.S. (Murray *et al.* 2008).

Range Contraction in the DPS - In response to climate change, lynx range in the DPS is expected to contract from boreal habitat shifting to higher elevation (Danby and H k 2007, pp. 360-362) and northward shifts in latitudinal distribution of boreal habitat and snow conditions (Sturm *et al.* 2001, pp. 342-342; Gonzales *et al.* 2010, pp. 761-766; Koen *et al.* 2015. p. 528; ILBT 2013, p. 69). For example, lynx distribution in southeastern Ontario has shifted northward >175 km over the past 40 years (Koen *et al.* 2014, pp. 757-758). Habitat patches will become smaller, more fragmented and isolated (Carroll 2007, pp. 1099-1100; Johnston *et al.* 2012, p. 11), bobcat distribution will expand northward (see below), and lynx will become more vulnerable to stochastic and environmental and demographic effects because of smaller population sizes and increased isolation.

Reduction in Periodicity and Amplitude of the Hare Cycle - Climate change influences ecological processes by altering large-scale climate systems such as the North Atlantic Oscillation, Southern Oscillation, Pacific North American Index, and North Pacific Index which, in turn, affect patterns of temperature and snow in North America (Stenseth *et al.* 2003, entire). Climate change-induced disruptions are believed to have caused the collapse of cycles in voles, lemmings, and snowshoe hares (Ims *et al.* 2008, p. 81; Cornulier *et al.* 2013, entire; Krebs *et al.* 2010, pp. 484-488). The geographical borders between cyclic and noncyclic populations are shifting, and the spatial extents of regions that have cycles are shrinking. The collapse of cycles in herbivores with high-amplitude population cycles also would imply collapses of important ecosystem functions such as pulsed flows of resources and disturbances throughout the

ecosystem, including declines in predator communities (Schmitz *et al.* 2003, p. 1202; Ims *et al.* 2008, p. 85). A common denominator of cycles that exhibit spatial gradients, such as the more pronounced snowshoe hare cycles in the northern part of its North American range, is that the cycles seem to fade as winters become shorter (Ims *et al.* 2008, p. 81).

Changes in large-scale climate systems have already influenced the climate and snow conditions throughout the geographic range of the lynx in North America (Stenseth *et al.* 1999, entire; Krebs *et al.* 2001a, p. 34; Brown 2000, pp. 2347-2354). Yan *et al.* 2013 (p. 3269) provide the first evidence of the negative effects of climate warming on hare-lynx cycles in Canada. The authors concluded that climate forcing is not only essential in producing sustained cycles, but is also essential in modifying the cycle intervals (Yan *et al.* 2013, p. 3269). Collapses in lynx fur harvests in Canada beginning in the mid-1980s may be linked to warming (Yan *et al.* 2013, p. 3269). With more pronounced troughs in hare abundance cycles, lynx populations will decline (Hone *et al.* 2011, p. 424). Diminished lynx populations in the core of the range in Canada is a concern because most of the populations of lynx in the DPS are believed to be dependent on periodic immigration from Canada for demographic persistence and genetic stability (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789, 68 FR 40091, 40097-40100). If diminished amplitude of the hare cycle in Canada continues, it will likely translate into a reduced potential for lynx to expand into new or unoccupied habitat in Canada or the adjoining U.S. (ILBT 2013, p. 69).

Reduction in Snow Conditions that are Necessary to Provide Lynx a Competitive Advantage - Climate-induced changes in snow depth and quality are critical because they reduce the extent of deep, fluffy snow habitat available to lynx (Knowles *et al.* 2006, p. 4557; Carroll 2007, p. 1103; McKelvey *et al.* 2011, pp. 2893-2895; Lynx BioTeam 2012 p. 69; Gonzales *et al.* 2007, pp. 7-8). Across their worldwide distribution, lynx rely on deep, powdery and persistent snow because they restrict potential lynx competitors such as bobcat or coyote and predators such as fishers and cougars from effectively encroaching on or hunting hares in winter lynx habitat (Peers *et al.* 2016, entire; 79 FR 54809).

Warmer winter temperatures are reducing snowpack in all portions of the lynx DPS through a combination of a higher proportion of precipitation falling as rain and higher rates of snowmelt during winter (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Hoving 2001, pp. 73–75; Mote 2003, p. 3–1; Christensen *et al.* 2004, p.347; Knowles *et al.* 2006, pp. 4548–4549). These trends are expected to continue with future climate warming (Hamlet and Lettenmaier 1999, p. 1611; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 48; IPCC 2007b, p. 850). The IPCC (2007b, p. 850) concludes that ‘‘snow season length and snow depth are very likely to decrease in most of North America except in the northernmost part of Canada where maximum snow depth is likely to increase.’’ Shifts in the timing of the initiation of spring runoff toward earlier dates in western North America are also well documented (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Cayan *et al.* 2001, pp. 409–410; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 41; Knowles *et al.* 2006, p. 4554). In addition, a feedback (albedo) effect is accelerating the rate of loss of snow cover because of the reflective

nature of snow and the relative heat-absorbing properties of non-snow-covered ground. This feedback effect causes the greatest warming to occur at the interface of snow-covered and exposed areas, increasing the rate at which melting occurs in spring (Groisman *et al.* 1994a, pp. 1637–1648; Groisman *et al.* 1994b, pp. 198–200). This effect has led to the average date of peak snowmelt to shift 3 weeks earlier in spring in the Intermountain West (Fagre 2005, p. 4). This albedo effect is further exacerbated by atmospheric soot and desert dust on snow ((Qian *et al.* 2009, entire; Painter *et al.* 2007, entire) and fire-darkened landscapes (Amiro *et al.* 2006, pp. 47-49). Snow accumulation and duration are expected to decline generally in the geographic areas that contain the central and eastern portion of the lynx DPS (IPCC 2007c, p. 891; Burns *et al.* 2009, p. 31). Because lynx require prolonged periods of deep fluffy snow, current habitats that lose this feature would decline in value for lynx (Hoving 2001, p. 73; Carroll 2007, p. 1092; Gonzalez *et al.* 2007, entire).

Reduced snow depth and duration may reduce lynx's competitive advantage over bobcats, which have similar ecology to lynx but are not as well-adapted to hunting hares in deep fluffy snow (Hoving 2001, pp. 23–24; Carroll 2007, p. 1102; ILBT 2013, pp. 69, 71). The bobcat is the closest related species to lynx in North America, and it outcompetes or displaces lynx wherever the two species overlap, at both broad (Peers *et al.* 2016, entire) and local (Parker *et al.* 1983, Robinson 2006, pp. 120-129) geographic scales. In areas where they do overlap, lynx are subjected to niche displacement to habitats of inferior quality, which probably limits lynx survival and productivity at the southern edge of their range (Peers *et al.* 2016, entire; Robinson 2006, pp. 120). Snow depth likely acts as a mediator of competition between the two species. Bobcats have a higher foot loading than lynx, are unable to hunt hares successfully in areas with deep, soft snow (Krohn *et al.* 2005, pp. 122-129, Hoving *et al.* 2005, entire), and experience high mortality in deep snow winters (Litvaitis *et al.* 1986, p. 116). Lynx have a low foot loading and long legs (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, pp. 122-129) that gives them a competitive advantage over bobcats in deep, fluffy snow conditions. This has important implications for lynx persistence and range distribution at the southern edge of their range considering the current and projected changes in snow cover, stable or increasing bobcat populations in the DPS (Roberts and Crimmins 2010, p. 170), and the predicted northward expansion of bobcats into areas currently occupied by lynx (Lavoie *et al.* 2009, pp. 873-874; Roberts and Crimmins 2010, p. 172; Anderson and Lovallo 2003, p. 758).

Buskirk *et al.* (2000a, entire) described exploitation (competition for food) and interference (avoidance) competition from bobcats and other species that may compete with lynx. Exploitation competition could contribute to lynx starvation and reduced recruitment. Of several predators examined (raptors, coyote, gray wolf, cougar, bobcat, and wolverine), coyotes were deemed the most likely to pose local or regionally important exploitation impacts to lynx. Coyotes, bobcats, and cougars are possibly capable of imparting interference competition effects on lynx. Interference would be most probable during summer and during winter in areas lacking deep, unconsolidated snow (ILBT 2013, p. 36). Cougars are also predators of lynx in the West (ILBT 2013, p. 35), but, like bobcats, cougars also have high foot loading, which limits their efficiency in deep, fluffy snow (Buskirk *et al.* 2000a, p. 90). Fishers are predators of lynx in

Maine (Vashon *et al.* 2012), but their distribution and movements in winter are also limited by deep, unconsolidated snow (Krohn *et al.* 2004, entire).

The effects of lynx-bobcat hybridization on lynx populations in the DPS are uncertain. Bobcats have hybridized with lynx in Minnesota, Maine, and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where low topographic relief and variability in winter severity may allow more interaction between the two species during the breeding season (ILBT 2013, p. 34). Hybrids were capable of reproducing successfully (Homyack *et al.* 2008, p. 507). The hybridization rate is currently low between the species (0.24 percent) but could increase as bobcat populations move north with climate change (Murray *et al.* 2007, p. 1465; Koen *et al.* 2015, p. 528).

Reductions in Hare Populations - In addition to affecting the synchronicity and amplitude of hare cycles, climate change will l kely affect hare populations in several different ways, especially at the southern extent of the range. Changing snow conditions may influence lynx hunting behavior and effectiveness. For example, hard-packed snow is reported to be associated with a higher kill rate of hares by lynx and coyotes than soft snow (Stenseth *et al.* 2004, p. 10633, Buskirk *et al.* 2000, p. 94). The higher kill rate could generate a numeric response by lynx and other hare predators (Hone *et al.* 2011, p. 420) that could drive hare populations to lower levels (Stenseth *et al.* 2004, p. 10633). Predator communities are more diverse at the southern part of the lynx range than in central Canada (Murray *et al.* 2008, pp. 1464-1465). The diverse predator community could explain why hare populations have declined and seem to remain low in Maine (Scott 2009, p. 43). Climate change will cause increased annual precipitation, periods of drought and extreme precipitation, and hotter summers across the northern tier of U. S. (i.e., throughout the DPS) in eastern North America (Jacobson *et al.* 2009, pp. 14-15, Romero-Lankao 2014, pp. 1452-1456). Increased precipitation may reduce hare numbers because the second litters of snowshoe hares have lower survival in wet summers (Meslow and Keith 1971, entire). However, because hares have two to four litters per summer, there is opportunity for compensatory survival of later litters if one is affected by weather (Krebs *et al.* 2014, p. 1043). Decreased hare survival may also be expected during prolonged hot, dry summer conditions. For example, hare densities in the GYA are believed to be low, in part, because of the dry conditions there (Hodges *et al.* 2009, p. XX). In dry western forests like those in the GYA, increased precipitation may result in more herbaceous forage and cover, which may promote hare survival and reproduction (Ivan *et al.* 2014, p. 590). Thus, climate change may have both positive and negative effects on hares.

Finally, the shorter duration and diminished snow cover in the DPS is causing an increasingly pronounced mismatch in the phenology of hare pelage change that may reduce hare survival (Zimova *et al.* 2013, entire; Mills *et al.* 2013, entire; 2014, entire). Diminished snow duration by as much as 8 weeks by the end of the century could have population-level effects on hares at the southern edge of their range. Hares exhibit plasticity in the rate at which they can molt from white to brown in the spring, but not in the initiation date of color change or the fall transition from brown to white (Mills *et al.* 2013, pp. 7362-7363). Hares do not seem to compensate for mismatched pelage by changing their behavior related to concealment, thus predisposing them

to predation (Mills *et al.* 2014, entire). There is wide variability in the timing of pelage change by individual hares within populations, and “mismatched” hares experience increased mortality rates (Zimova *et al.* 2016, p. 302). Under high emission scenarios, this could lead to an 11 percent decline in hare survival by mid-century and a 23 percent decline by late century. Diminished survival would lead to steep (high emissions) to moderate (medium-low emissions) declines in hare populations (Zimova *et al.* 2016, p. 304). It is also poss ble that this phenological mismatch may dampen hare cycles (Zimova *et al.* 2016, p. 305). Snow patterns have been proposed to potentially play a role in dampening cycles (Cornulier *et al.* 2013, pp. 64-65, Sultaire *et al.* 2016a, entire).

The range of the snowshoe hare is contracting northward in the southern part of its range in the contiguous U. S. because of changing snow conditions and reduced survival because of delayed pelage changes (Diefenbach *et al.* 2016, p. 245; Sultaire *et al.* 2016a, entire). In Wisconsin, snowshoe hare range has been contracting northward an average of 8.7 km per decade and will continue to recede northward with climate change (Sultaire *et al.* 2016a, entire). Loss of snow now contributes more than loss of habitat in determining the range of snowshoe hares in the Great Lakes region (Sultaire *et al.* 2016a, entire).

Reduction in Lynx and Hare Habitats - Climate change will diminish the amount of lynx habitat throughout the DPS by a) reducing the areas where snow conditions give lynx a competitive advantage over bobcats and other species, and b) reducing the amount of spruce-fir habitat required by snowshoe hares. An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Areas of contiguous spring snow cover will become smaller and more isolated throughout the Columbia, Upper Missouri, and Upper Colorado Basins, with greatest losses at the southern periphery, which likely is an indicator of the trajectory of lynx habitat (McKelvey *et al.* 2011). Deteriorating snow conditions caused by climate change is causing range contraction of snowshoe hares and the southern edge of their range (Sultaire *et al.* 2016b, pp. 900-904). Similarly, because of diminishing snow resources, potential lynx habitat is diminishing in the northern Appalachians and small areas in the Canadian Maritime Provinces (Carroll 2007, p. 1093).

Changes in temperature and rainfall patterns are expected to shift the distribution of ecosystems northward and up mountain slopes (McDonald and Brown 1992, pp. 411–412; Danby and Hik 2007, pp. 358–359; IPCC 2007c, pp. 230, 232). As climate changes over a landscape, the ecosystems that support lynx are likely to shift, tracking the change of temperature, but with a time lag depending on the ability of individual plant and animal species to migrate (McDonald and Brown 1992, pp. 413–414; Hall and Fagre 2003, p. 138; Peterson 2003, p. 652). On the basis of the best existing data for 130 tree species in North America and associated climate information, and assuming no limitations to individual tree growth, McKenney *et al.* (2007) predicted that the average range for a given tree species will decrease in size by 12 percent and will shift northward by 700 kilometers (km) during this century. In the contiguous U.S., researchers expect that lynx in mountainous habitat will, to some extent, track climate changes

by using higher elevations on mountain slopes, assuming that vegetation communities supportive of lynx and hare habitats also move upslope (Gonzalez *et al.* 2007, p. 7). Some areas of the DPS (e.g., Maine, Minnesota) lack elevational refugia and, therefore, lynx populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102).

These studies predict lynx and hare habitats—boreal spruce-fir and subalpine forests—and, therefore, lynx distribution, are likely to shift upward in elevation within its currently occupied range and recede northward as temperatures increase (Gonzalez *et al.* 2007, pp. 7, 13–14, 19; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, pp. 26–27, 30–31; Vashon *et al.* 2012, pp. 60, 64; ILBT 2013, p. 69). Lienard *et al.* (2016, p. 7) assessed forests in New England, Northern Great Plains, and higher elevations in the Rockies, including spruce-fir types, as vulnerable to drought-related stress from climate change during the next century. The boreal spruce-fir forests that provide habitat for lynx and snowshoe hares are thought to be limited by summer temperatures and drought (Iverson and Prasad 2001, pp.192–196) and, under a suite of emissions and climate change scenarios, are projected to diminish dramatically or disappear from much of the eastern U.S. (Iverson and Prasad 2001, p. 196; Iverson *et al.* 2008, pp. 390–400). Within the last 20 to 25 years, widespread mortality and reduced growth in red spruce in the Northeast are believed to be linked to climate stress (McLaughlin *et al.* 1987, p. 501, Johnson *et al.* 1988, p. 5373.). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103).

Climate change is disproportionately affecting the boreal forest in Canada, the source of lynx dispersing into the DPS. Arctic and alpine ecosystems are among the most sensitive to climate warming (Diaz and Eischeid 2007, entire). Boreal forests have been identified as a critical "tipping element" of the Earth's climate system and are believed to be more sensitive to drought than other forests (Lenton *et al.* 2008, pp. 1788, 1791). Studies suggest a threshold for boreal forest dieback of ~ 3 °C global warming (Lucht *et al.* 2006, entire, Joos *et al.* 2001, entire). Global temperatures are increasing and snowfall is declining at the fastest rate in higher latitudes within the boreal forest region of Canada and Eurasia (IPCC 2007). Predicted changes to the boreal forest are already occurring, and much of the climate-induced change is occurring faster than originally predicted, suggesting rapid change as opposed to slow linear change (Soja *et al.* 2007, pp. 5-6). General circulation models are in agreement that winter warming across the circumboreal region will be in excess of 40 percent above the global mean (Soja *et al.* 2007, p. 4). Increases in precipitation are expected in the boreal region of Canada, particularly during the winter, but may be offset with increases in summer drought, heat stress and evapotranspiration (Stocks *et al.* 1998, entire). Thus, boreal forests are experiencing rapid increases in tree mortality (Peng *et al.* 2011, entire). Several authors have suggested that grasslands, aspen parklands, and temperate forest will expand northward resulting in decreases in boreal forest (Rizzo and Wiken 1992, p. 50; Starfield and Chapin 1996, entire; Rupp *et al.* 2000, entire), which could further fragment spruce-fir habitat (Iverson *et al.* 2008, p. 404; Tang

and Beckage 2010, pp. 152-156; Simons-Legaard *et al.* 2016, p. 5; Rustad *et al.* 2012, p. 15). Climate change is expected to further fragment boreal forest in southern Canada (Hogg 1994, entire) and would reduce habitat connectivity between lynx populations in the contiguous U. S. and southern Canada.

Changes in the Frequency and Pattern of Disturbance Events – The distr bution, amount, and composition of lynx habitat could be rapidly and dramatically altered by an increasing occurrence and persistence of drought, along with associated outbreaks of insects and pathogens, wind and ice storms, and wildfires (ILBT 2013, p. 70). All of these factors are potentially interrelated with multiple feedback mechanisms, and some have a cascading effect (Dale *et al.* 2001, p. 729). For example, drought can weaken trees, increasing their vulnerability to insects and pathogens. Insects and pathogens can create dead trees or increase fuel loads, potentially increasing the risk and intensity of fire. The boreal forest is a complex and variable system, and these effects are expected to vary in time and space. Climate change may compound these complex interactions into new domains that may be unprecedented and unpredicted (Dale *et al.* 2001, p. 729). These interactions may appear slowly and be difficult to detect because trees live for so long or they be manifested quickly after a catastrophic perturbation to the forest.

Climate change-induced drought and heat stress have already affected temperate and boreal forest (Allen *et al.* 2010, entire), particularly in the West where tree mortality rates have increased rapidly in recent decades (van Mantgem *et al.* 2009, entire). Droughts occur irregularly in forests in eastern North America and the Pacific Northwest, annually at the end of the growing season in forests at the midcontinental prairie–forest border, and annually in summer in western interior dry forests that depend on winter precipitation (Dale *et al.* 2001, p. 727). Increase in growing-season temperature could increase evaporative demand, triggering moisture stress. Under several climate scenarios, future increases in drought stress are expected in the Southern Rockies and parts of the Northwest (Dale *et al.* 2001, p. 727). The Great Lakes region and parts of the Northwest could experience drought stress within two decades, even though these regions may become wetter in later decades (Dale *et al.* 2001, p. 727).

The frequency of wildfire is increasing in boreal forests of North America. Extended fire seasons and increases in the total area burned are anticipated in the western U.S. with continued climate warming (McKenzie *et al.* 2004). Evaluating wildfire patterns in the western U.S. from 1970-2004, Westerling *et al.* (2006, entire) found rapid and dramatic increases in the frequency of large fires, wildfire durations, and the length of the wildfire season beginning in the mid-1980s. Mesic, middle- and high-elevation forest types (such as lodgepole pine and spruce-fir) in the northern Rocky Mountains experienced the greatest increases. Increased spring and summer temperatures and an earlier spring snowmelt strongly influenced large wildfires, suggesting that climate is the primary driver of these changes rather than fire exclusion (suppression), which appears to have had little impact on natural fire regimes of these higher-elevation forest types in this area ILBT 2013, p. 70).. In contrast, climate change is increasing precipitation in boreal forest regions of eastern North America, which has reduced wildfire frequency (Bergeron *et al.*

2001, p. 388). Under multiple climate scenarios, large increases in fire frequency are expected for boreal forest in central and western Canada, and reduced frequency in eastern Canada - a situation that reflects past Paleoclimates that were warmer than the present (Flannigan *et al.* 2001, pp. 860-862). Increased fire frequency at the grassland – aspen parkland – boreal forest transition in western Canada may hasten the conversion of boreal forest to aspen parkland and aspen parkland to grassland (Flannigan *et al.* 2001, p. 860-861), which could affect connectivity and gene flow in lynx populations.

Warmer springs could increase the frequency and duration of wildfires, which in turn could increase vulnerability of surviving trees to bark beetle attack (Westerling *et al.* 2006; ILBT 2013, p. 70). Increasing temperatures and forest homogeneity could create conditions favorable for bark beetle outbreaks that exceed natural disturbance thresholds, perhaps increasing the l kelihood of additional outbreaks in the resulting large areas of even-aged forests (Raffa *et al.* 2008; ILBT 2013, p. 70).

Climate change is dramatically affecting the frequency and intensity of some eruptive boreal forest insect pests and pathogens that affect disturbance patterns in spruce-fir forests. Changes in temperature and precipitation affect herbivore and pathogen survival, reproduction, dispersal, and distr bution. For example, native bark beetles, such as the spruce beetle and mountain pine beetle, are key agents of change in coniferous forest ecosystems in western North America and have recently defoliated millions of hectares – among the largest and most severe in recorded history (Bentz *et al.* 2009). Drought-stressed conifers have increased vulnerability to insect attack. By the end of the century, changes in temperatures across the boreal forests of western North America may cause markedly high probability of outbreak of these species (Bentz *et al.* 2010. pp. 607, 609). In contrast, the range of the spruce budworm, a major pest of spruce-fir ecosystems in eastern North America, is expected to shift northward reducing vulnerability of spruce-fir forests in Maine and Minnesota (Regniere *et al.* 2010, entire). However, widespread clearcutting following the most recent spruce budworm outbreak in Maine was the primary driver creating widespread lynx habitat (Hoving *et al.* 2005, Vashon *et al.* 2012).

Introduced species can affect forests through herbivory, predation, habitat change, competition, alteration of gene pools via hybridization with natives, and disease (as either pathogens or vectors) and can alter the diversity, nutrient cycles, forest succession, and fire frequency and intensity of some ecosystems (Dale *et al.* 2001, p. 727). Climate change will modify the distributions of many introduced species. Currently, there are few exotic species in North American boreal forests. This is likely because remote areas with little human intervention receive fewer exotic species. However, exotic species could be introduced in the future as boreal systems are increasingly exploited for forest products, mining, energy production, and other natural resources (Schinder and Lee 2010, entire).

Ice storms occur throughout the northern U.S.but are most frequent in the Northeast (Dale *et al.* 2001, p. 728). For example, in January, 1998 a severe ice storm extensively damaged the canopy of many northeastern U.S. and eastern Canadian forests, causing moderate to severe forest damage to over 10 million acres in the Northeast U.S. and southern Quebec (Irland 2000,

entire; Millward and Kraft 2004, entire; Jones and Mulhern 1998, p. 19). Ice storm damage to stands can range from light and patchy to total breakage of all mature stems over extensive areas (Irland 2000, entire). It is uncertain how climate change will affect the frequency, intensity, location, and extent of ice storms; however, atmospheric warming will most likely shift the locations of prevailing ice storms northward.

Introduction of Lynx or Hare Disease and Parasites - Climate change can increase pathogen development and survival rates, disease transmission, and host susceptibility, and some species are predicted to experience more frequent or severe disease impacts with warming while others may be relieved of pathogens (Harvell *et al.* 2002, entire, Harvell *et al.* 2009, entire). Climate change is likely to cause major changes to the geographic range and incidence of insect and tick-borne diseases (Daszak *et al.* 2000).

No apparent climate-influenced parasites or diseases have been identified that would affect Canada lynx or snowshoe hares, but experts believed this was difficult to predict and a possibility (Lynx SSA Team 2016, pp. 27, 37-39). A few pathogens have been documented in lynx in the DPS. For example, plague, a flea-borne disease caused by the bacterium *Yersinia pestis*, which is not native to North America, was reported for the first time in lynx in Colorado (Wild *et al.* 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 lynx released in Colorado between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to *Y. pestis*; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado. Exposure of some lynx to feline parvovirus was detected in six areas in western North America (Montana-Alaska)(Biek *et al.* 2002). *Troglostongylus wilsoni* is a nematode that infects the lungs of lynx and bobcats (Sarmiento 1956, Van Zyll de Jong 1966, Kumar 1974, and Reichard 2004) and was detected in Maine lynx (Vashon *et al.* 2012, p. 24). Lynx with heavy infestations have difficulty breathing and succumb to starvation, as occurred with several Maine lynx (Vashon *et al.* 2012, p. 24).

Reduction in Gene Flow - Koen *et al.* (2014, entire) hypothesized that climate change would create increasingly unsuitable environmental conditions for lynx (e.g., milder winters with reduced snow quality, declining and fragmented boreal forest), which was associated with low genetic diversity and high genetic differentiation at the trailing (southern) edge of the range. Furthermore, high winter temperature, low snow depth, and low proportion of suitable habitat were strongly correlated with neutral genetic diversity, low allelic richness, and high genetic differentiation (Koen *et al.* 2014, p. 757). The authors surmised that genetic structuring in southern lynx populations could be caused by a northward shift in optimal conditions, resulting in isolation and extirpation of lynx populations at the trailing edge of their range or climate-induced changes in the distributions of snowshoe hare or bobcats causing lynx to shift northward. Lynx with the greatest allelic richness were found in areas with the deepest snow in the core of their range in northern Ontario (Koen *et al.* 2014, p. 758). The authors concluded that climate warming has reduced gene flow at the receding (southern) edge of the lynx's range, and that southward gene flow from Canada into threatened U.S. populations is unlikely (Koen *et al.* 2014, p. 760). Stenseth *et al.* (2004, entire) documented population and genetic structuring in the lynx populations east and west of Hudson Bay based on differences in snow conditions on

either side of this divide. This may be explained by the reluctance of lynx to disperse between areas having different snow regimes and snow quality. Snow conditions may be the key factor in the spatial, ecological, and genetic structuring of Canada lynx (Stenseth *et al.* 2014, pp. 10633-10644).

Climate warming may further isolate lynx populations, thus reducing gene flow, by reducing connectivity between populations. For example, gene flow between eastern Canada and Maine lynx populations depends on an ice bridge for dispersal across the St. Lawrence River. Although some lynx currently cross the river, Koen *et al.* (2014, entire) found genetic structuring on either side of the river. Thus, the river already restricts gene flow. Climate-induced deteriorating ice conditions on the St. Lawrence River could further restrict gene flow between lynx populations north and south of the river (Koen *et al.* 2014, p. 528). Between 1969 and 2002 there was a 20 to 40 percent reduction in sea-ice cover during the spring thaw in the Gulf of the St. Lawrence (Johnston *et al.* 2005). Conversely, reduced ice on the St. Lawrence may prevent bobcats from dispersing northward into lynx areas in central Quebec (Koen *et al.* 2014, p. 528).

3.3 Vegetation Management

Forest management occurs across the range of the lynx and can directly affect important habitats and prey. At the time of listing, management activities uninformed by consideration of negative impacts to the species were identified as being of greatest potential concern to lynx conservation (68 FR 40076-40101). Forest management is the most prevalent land use throughout the lynx DPS and can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitat and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Forest management affects stand structure, composition, and arrangement on the landscape, which are important elements of habitat for snowshoe hares and lynx. At the home range scale, lynx throughout the DPS select landscapes having the greatest snowshoe hare densities. In Maine and Minnesota these are young, regenerating spruce-fir forests (Hoving *et al.* 2004, McCann and Moen 2011) and in the West regenerating lodgepole pine (Koehler, Maletzke, Berg *et al.* 2012) and dense mature conifer forest, as well as young stands with dense spruce-fir saplings (Griffin 2004, Squires *et al.* 2010, pp. 1648, 1653–1656; Berg *et al.* 2012). Silvicultural prescriptions and cutting practices in boreal forest types vary widely throughout the lynx DPS depending on the landowner, forest ecology and ecoregion, tree species, site conditions (e.g. moisture, slope, aspect), disturbance regimes (e.g., fire, insect outbreaks), forest policy and regulations, logging equipment, and markets for forest products. Forest management that creates habitat for hares and lynx in one geographic area may not be beneficial to hares and lynx in another.

Nevertheless, snowshoe hares throughout the DPS range respond to one common denominator. Dense understory (horizontal cover) is the most important forest structural characteristics for hares throughout their range (Ferron and Ouellet 1992, Wolfe *et al.* 1982, Litvaitis *et al.* 1985). Dense, horizontal cover provides hares with a source of browse and cover from predation. Softwood (e.g., spruce-fir) has about three times more cover value than hardwoods (Litvaitis *et al.* 1985). Thus, stem density (or stem cover units) and snowshoe hare

density are directly and positively correlated (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Koehler and Brittell 1990, Thomas *et al.* 1997, Hodges 2000a, Mowat *et al.* 2000, Homyack *et al.* 2006, Robinson 2006, Scott 2009, Fuller and Harrison 2013). Forest practices that promote high stem density and dense horizontal cover can increase snowshoe hare densities (Keith and Surrendi 1971; Fox 1978; Conroy *et al.* 1979; Wolff 1980; Parker *et al.* 1983; Livaitis *et al.* 1985; Bailey *et al.* 1986; Monthey 1986; Koehler 1990a, b; Robinson 2006; Fuller *et al.* 2007; Homyack *et al.* 2007; Scott 2009; McCann and Moen 2011). Forest practices that reduce dense understory generally reduce habitat quality for hares and lynx.

Effects of forest practices on snowshoe hare habitats have been studied across the range of the species (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Thomas *et al.* 1997, Homyack *et al.* 2005, Robinson 2006, Griffin and Mills 2007, Scott 2009, Berg 2010, Ivan 2011a, Lewis *et al.* 2011, McCann and Moen 2011). Similarly, the effects of forest management on lynx habitat use, movements, and home range have been investigated by Koehler (1990a), Koehler and Brittell (1990), Fuller *et al.* (2007), Homyack *et al.* (2007), Moen *et al.* (2008), Vashon *et al.* (2008b), Simons (2009), Squires *et al.* (2010), Simons-Legaard *et al.* (2013), Simons-Legaard *et al.* (2016).

Historically, the dominant natural disturbance processes that created young, regenerating conifer forest conducive to hares and lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of northern Maine, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S. After disturbances, forests generally develop through several stages descr bed by Oliver (1980) as “stand initiation,” “stem exclusion,” “understory reinitiation,” and “old growth.” Stand dynamics, particularly within-stand competition for light, nutrients, and space, determine how forests grow and respond to intentional manipulations and natural disturbances (Oliver and Larson 1996). The frequency and severity of disturbances have a large role in determining which species will dominate in a stand after the disturbance event. Snowshoe hare and lynx habitat are created during the stand initiation stage, after the young trees have established and grown tall enough (1-3 meters) to protrude above the snow and provide adequate horizontal cover. During the stem exclusion stage (~10 meters depending on tree species) the tree crowns lift and lower branches self-prune, thus reducing the live horizontal branches providing food and cover for snowshoe hares. In the old growth stage, understory may re-develop (e.g., in forest gaps where mature trees die or fall down) and food and cover may again become available to support snowshoe hares.

Commercial timber management of conifer forests traditionally has been designed to: in very young, regenerating forest to select for desired species (e.g., herbiciding, plantations) and reduce tree density to promote tree growth (e.g., precommercial thinning); in young middle-aged forest to improve growth and vigor of mature trees (e.g., commercial thinning, pruning, thinning from below); and in mature forest to reduce the vulnerability of commercially valuable trees to insects, disease, and fire (e.g., commercial thinning, group selection, fuels reduction). The

culmination of the process (or a forest rotation) is harvesting of forest products. Just as the timing and intensity of a natural disturbance affects the composition of the succeeding forest, the season, climate, machinery, and type of final harvest (e.g., clearcut v. partial harvest) have a large role in determining the species composition and health of the next crop of trees. Timber management practices may mimic natural disturbance processes but often are not an exact ecological substitute. Some practices, such as use of herbicides to suppress hardwood regeneration or plantations do not have an historical analogue. Timber harvest may differ from natural disturbances by:

- Removing most standing biomass from the site, especially larger size classes of trees, and down logs, which alters microsite conditions and nutrient cycling;
- Creating smaller, more dispersed patches and concentrating harvest at lower elevations in mountainous regions and on more nutrient rich soils, resulting in habitat fragmentation;
- Causing soil disturbance and compaction by heavy equipment, which may result in increased water runoff and slower tree growth at the site; or
- Giving a competitive advantage to commercially-valuable tree species and reducing the structural complexity of the forest through the application of harvest, planting, thinning, and herbicide treatments.
- Forest practices often have a smaller footprint on the landscape than widespread fire, insect, or wind damage.

Forest management may (or may not) be compatible with creating or maintaining habitats capable of supporting hares and lynx. Where the objective is to provide snowshoe hare habitat by creating additional early-successional forest conditions, management considerations include selecting areas that are capable of, but not currently providing, dense horizontal cover, designing the appropriate size and shape of treatment units, retaining coarse woody debris, and maintaining high stem densities in regenerated forests (Koehler and Brittell 1990, Homyack *et al.* 2004, Bull *et al.* 2005, Fuller and Harrison 2005, Ivan 2011a).

North America is the world's leading producer and consumer of wood products. Therefore, worldwide trends in forest products markets greatly affect forest management outcomes and thus, the amount and quality of lynx habitat in the DPS. Forest management decisions (e.g., to focus on hardwood or softwood production) can change dramatically in response to unpredictable and changing forest products markets. Globalization of manufacturing and expanded use of electronic media have reduced demand in pulp and paper since the late 1990s, and the collapse of housing construction since 2006 have contributed to declines in U. S. wood product output. Within the northern region of the U. S. (Maine to North Dakota) there has been a considerable decline in terms of employment, mill numbers, wood consumption and forest harvests since 2000 (Woodall *et al.* 2011). As a large amount of this region's forest industry is print paper manufacturing and composite panel production, the rise of electronic media and decline of home construction has precipitated a decade of decline, which only deepened since the recession of 2007-2009. The West, prior to the recession, was a major softwood lumber producing region, and was particularly hard hit by the recession and housing

collapse. Employment dropped by 30 percent or nearly 80,000 workers and annual value of output fell by more than 25 percent (Keegan *et al.* 2011). Under depressed markets, landowners may reduce harvests, which may be to the detriment of lynx in some parts of the DPS (e.g., Maine and Minnesota), and to the benefit of lynx in others (the West).

Markets for softwood products are particularly volatile and depend on demand for paper and housing. Thus, softwood management is affected by economic factors that are difficult to predict. In recent years, the forest products industry throughout the U. S. experienced a downturn in output levels not seen in decades, and employment losses in the hundreds of thousands (Woodall *et al.* 2011, p. 595). Despite depressed markets, one area of increasing interest is bioenergy production. Rising energy costs and growing concerns over global climate change have increased interest in bioenergy production, and the U. S. Energy Independence and Security Act (2007) mandates a five-fold increase in biofuel production (Benjamin *et al.* 2009, p. 125). The wood pellet sector is expected to grow, although woody biomass is typically the lowest value wood commodity sold from the forest. Thus, it is questionable whether wood energy revenues would be enough to sustain forest investments and forest management into the future (Woodall *et al.* 2011, p. 601).

Whereas management of state and federal forest lands have been relatively stable in recent decades, management and ownership of private forest land ownership has been extremely unstable. This has resulted in major shifts in forest management strategies, outcomes, and products. For example, in the last two decades in Maine, where nearly all the lynx critical habitat is on private land, about 23.8 million acres (80 percent) of industrial land ownerships in the "northern forest" (Adirondacks to northern Maine) were sold to a host of financial groups (Hagan *et al.* 2005). These groups have short-term investment goals and different management objectives and have dramatically changed harvest practices. Whereas the previous large industrial landowners focused on the forest land base as a supply for their manufacturing facilities, the new TIMOs and REITs focus on maximizing return on their investment (Jin and Sader 2006, p. 178). Initially, the effects of ownership changes were uncertain (McWilliams *et al.* 2005), but an evaluation of harvesting in the last decade indicates these landowners increased harvest rates, shortened rotation rates, and shifted to managing and harvesting hardwood tree species (Jin and Sader 2006, p. 183-185). On one hand, these trends in Maine private lands management make lynx management commitments more difficult because short-term landowners are not interested in long-term commitments. On the other hand, some easement owners may have an incentive to manage for lynx to meet forest certification requirements.

The extensive sale of private forestlands initiated the growth of conservation easements in this region (deGooyer and Capen 2004, Lilieholm *et al.* 2010). Conservation land as a percentage of Maine's state area increased from less than 5 percent in 1987 to approximately 19 percent by 2012 (Beck *et al.* 2012, p. 15). Conservation easements restrict development but usually do not affect forest management; neither do they typically require management for lynx and other rare species. Some private forestlands were sold to state and federal agencies and conservation interests. For example, in recent years The Nature Conservancy purchased 310,000 acres of

private forestland in Montana and 185,000 acres of private forestland in northern Maine. Lands in conservation ownership have a high probability of being managed to benefit hares and lynx.

Finally, future trends in forest management will be affected by climate change (Irland *et al.* 2003, entire). Many models have been developed to project how U.S. timber production and markets may adapt to climate change (e.g. Burton *et al.* 1998, Joyce *et al.* 1995, Perez-Garcia *et al.* 1997, Sohngen and Mendelsohn 1998). Economic models predict that under climate change, total U.S. timber inventories will increase, timber harvest will increase, and product prices will decrease relative to an assumed stable climate. Some models predict that consumers will gain from climate change while landowners in some regions will lose. The forest industry will adapt to climate change in many ways including using alternate tree species in manufacturing, shifts to geographic regions of the country with economic advantages in timber growth, and increasing forest plantations with new species that are favorably adapted to the new climate and markets. Many strategies have been evaluated to increase the quantity of carbon stored in North American forests (Irland *et al.* 2003) including discontinuing or greatly reducing harvest in some forests to build carbon reserves, increased recycling to reduce use of forest products, converting agricultural lands to forests, and substituting wood products for more energy-intensive products. Increased atmospheric carbon will increase forest growth slightly, except for softwood (Irland *et al.* 2001, p. 757-758). Sawtimber production, which sequesters more carbon, is expected to increase (Irland *et al.* 2001, p. 758). Expanding landscapes with older growth conifer forest to sequester carbon could benefit lynx in the West and be to the detriment of lynx in the East.

Climate change will affect forest-related recreation. Warmer lowland temperatures will attract more people to relatively cooler mountainous and northern forests (Irland *et al.* 2001, p. 759). The ski industry is currently in decline, and climate-induced changes in snowfall will further stress this industry, except for higher elevation western resorts where snowfall is more dependable and where artificial snow is less expensive to make (Irland *et al.* 2001). These climate-induced trends in recreation are anticipated to bring more people into the lynx DPS, which could bring additional social pressures concerning decisions related to forest management (e.g. clearcutting) (Swanson and Loomis 1996). At this time, there are many uncertainties concerning the socioeconomic implications of climate change and adaptation in the northern forests supporting the lynx DPS.

Past and future forest management affects many of the requirements necessary for the continued existence of lynx in the DPS. Forest management is expected to be the predominant land use throughout the DPS into the foreseeable future, and major climate-induced changes in forest industry are anticipated (Irland *et al.* 2001, entire). Beneficial effects of forest management include 1) creating lynx habitat, 2) maintaining an undeveloped landscape conducive to lynx, and 3) long term management planning for lynx (especially on federal lands). Adverse effects to lynx, hares, and their habitat that are occurring or can be reasonably be anticipated include 1) reduced quality of hare habitat in some parts of the DPS, 2) loss and fragmentation of lynx and hare habitat in the U. S., and 3) changes in the frequency and pattern of disturbance events. Synergetic effects between forest management and other stressors (e.g.,

climate change, trapping, development) may intensify their effects (Carroll 2007). Habitat loss and fragmentation are believed to currently be the most important stressors for lynx in the DPS (Fig. X), but it is possible that other pathways for forest management are, or may become, equally important. Hares and lynx will continue to be affected (both positively and negatively) by forest management into the foreseeable future. Forest management stressors primarily affect lynx by lowering landscape hare densities, which in turn reduce lynx reproduction and lower

Reduced Quality of Hare Habitat - Throughout the lynx DPS, some vegetation management practices, especially thinning in young, dense regeneration, reducing overstory canopy in mature multi-story spruce-fir forests (in the West), and partial harvesting (in northern Maine) reduce the quality of boreal forest habitats for snowshoe hares and lynx. This could cause lynx to increase their home ranges, reduce productivity, or in extreme cases to abandon their home range or cause mortality.

Thinning of young, dense sapling stage conifers (precommercial thinning) is a forest management practice used widely throughout the DPS to increase the growth and value of selected trees and to reduce the time to maturity of a stand of trees. Precommercial thinning removes competing trees of the same species or shrubs and trees of other species (Daniel *et al.* 1979; Homyack *et al.* 2005, 2007). Reducing the density of sapling-sized conifers in young regenerating forests to increase the growth of certain selected trees promotes more homogeneous patches and reduces the amount and density of horizontal cover, which is needed to sustain snowshoe hares (Sullivan and Sullivan 1988, Hodges 2000b, Griffin and Mills 2004, Ausband and Baty 2005, Griffin and Mills 2007, Homyack *et al.* 2007, Ellsworth 2009). Hares reach highest densities in stands with stem densities ranging from 4,600–33,210 stems/ha (1,862–13,445 stems/ac)(Wolff 1980, Parker 1984, Litvaitis *et al.* 1985, Monthey 1986, Parker 1986, Koehler 1990a, Griffin 2004, Fuller and Harrison 2005, Robinson 2006, Scott 2009), whereas thinned stands have densities of 2990 (6-foot spacing) to 1,682 (8-foot spacing) stems/ha (Pitt and Lanteigne 2008, p. 593). Precommercial thinning has been shown to reduce hare numbers by as much as 2- and 3-fold (Griffin and Mills 2004, 2007; Homyack *et al.* 2007) because of reduced cover and decreased availability of browse. Griffin and Mills (2007) reported that, if their results were representative, the practice of precommercial thinning could significantly reduce snowshoe hares across the range of lynx.

There are anecdotal examples of precommercially thinned stands that subsequently "filled in" with understory trees. Some have suggested this could be a technique to extend the time that understory trees and low limbs provide the dense horizontal cover that constitutes snowshoe hare habitat. The duration between time of thinning and regrowth to a height providing winter snowshoe hare habitat would likely vary by tree species, each having different regenerative capacities that could be influenced by a variety of local factors (e.g., topographic relief, moisture, and mineral and organic content of the soil; Baumgartner *et al.* 1984, Koch 1996). Bull *et al.* (2005) reported that the slash and coarse woody debris remaining after precommercial thinning provided both forage and cover for snowshoe hares up to a year following treatment. However, Homyack *et al.* (2007) found that snowshoe hare densities were reduced following precommercial thinning for 1–11 years post-thinning. They further suggested that after

precommercial thinning, the stands did not regain the structural complexity in the understory that would be needed to support pre-treatment snowshoe hare densities. At this time, no other data are available to quantify the re-establishment of snowshoe hare habitat and over what time period, or the response by snowshoe hares, as compared with sites that were not precommercially thinned, so this remains an unproven management technique. As an alternative to standard precommercial thinning (i.e., complete thinning resulting in a homogeneous patch), Griffin and Mills (2007) suggested retaining at least 20 percent of the patch in untreated clumps of about ¼ ha (½ ac), which would maintain hare habitat in the short term. However, Lewis *et al.* (2011) found that landscapes with patches of high-quality habitat surrounded by similar vegetation supported more hares than did more fragmented landscapes composed of high-quality patches in a matrix of poorer-quality habitat. Further long-term studies of modified thinning methods are needed.

Because of documented adverse effects of precommercial thinning to snowshoe hares and lynx, in 2007 and 2008 the USFS amended Forest Plans to incorporate management that would conserve lynx, including direction that prohibited precommercial thinning in most lynx foraging habitat (USFS 2007, pp. 8, 11-14, 36; USFS 2008, pp. 6-9, 23-26) . However, precommercial thinning is not regulated on private forest lands throughout the remainder of the DPS.

Uneven-aged management (single tree, partial harvest, and small group selection) practices can be employed in stands where there is a poorly developed understory, but have the potential to produce dense horizontal cover for snowshoe hares. Removal of select large trees can create openings in the canopy that mimic gap dynamics and help to maintain and encourage multistory attr butes within the stand. However, if removal of large trees opens the canopy to the extent that the patch functions as an opening, this may discourage use by lynx (Koehler 1990a, von Kienast 2003, Maletzke 2004, Squires *et al.* 2010). Removal of larger trees from mature multi-story forest stands to reduce competition and increase tree growth or resistance to forest insects may reduce the horizontal cover (e.g., boughs on snow), thus degrading the quality of winter habitat for lynx (Robinson 2006, Koehler *et al.* 2008, Squires *et al.* 2010). Similarly, removing understory trees from mature multi-story forest stands reduces the dense horizontal cover selected by snowshoe hares, and thus reduces winter habitat.

Partial harvesting broadly describes many methods of removing a portion of the overstory trees from a forest stand. Partial harvesting includes selective cuts, shelterwood cuts, and uneven-aged management. Partial harvest may be “light” (e.g., <10 percent of trees removed) to “heavy” (e.g., 90 percent of trees removed). Since passage of the Maine Forest Practices Act in 1989, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine (Sader *et al.* 2003, entire). In recent years, about 425,000 acres of Maine forest are harvested annually and 96 percent of this land is partially harvested (Maine Forest Service 2016? Check). After 17 years of extensive partial harvests, much of the northern Maine landscape has been influenced by this form of forestry, and will continue to be into the future. The popularity of this form of harvesting extends beyond Maine. From the mid-1980s to mid-1990s, partial harvesting comprised 62 percent of the harvest in the U. S., and clearcuts comprised the other 38 percent. Partially harvested stands result in a wide range of

residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006). On average, partially harvested stands supported about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006). Shelterwood cuts, a form of even-aged management, are the exception and have maintained densities similar to regenerating clearcut stands (D. Harrison, U. Maine, unpubl. data). Current hare densities in partially harvested stands in Maine average about 0.4 hares/ha (Simons 2009, p. XXX, check), which is below the landscape hare densities (0.5 hares/ha (Ruggiero *et al.* 2000b, Simons-Legaard *et al.* 2013) needed to support lynx.

In the Great Lakes Geographic Unit, prescr bed burning is used in lynx habitat primarily as a tool to reduce fuels (including from blow-down) and mimic a more natural fire regime in pine forest types (Plate 4.4). In these instances there is a short-term (10–30 years) impact on snowshoe hare habitat. In the western U.S., prescribed fire for ecosystem restoration is most applicable to the dry ponderosa pine and Douglas-fir forests that are not lynx habitat. Because spruce-fir forests are generally composed of thinner-barked trees that are easily killed even with light fire, this technique is not used frequently in most lynx habitat.

Biomass removal for energy production targets the removal of dead trees, logging slash, and small-diameter trees and shrubs. Biomass removal is similar to fuels treatments in reducing cover and habitat for snowshoe hares.

Fuels treatments commonly are designed to remove understory biomass and reduce stem density in forests that are outside their historical range of variability, and to clear fuels adjacent to human developments for safety or to protect investments (Plate 4.3). These types of projects are becoming more common. In the western U.S., projects designed to restore forests to a condition more representative of the historical range of variability are generally targeted to drier, lower-elevation forests affected by fire suppression (Hessburg *et al.* 2005), which are not lynx habitat. Lynx habitats in higher-elevation spruce-fir forests have been less affected by past fire suppression and are mostly within the historical range of variability (Agee 2000). Fuels treatments may be needed to protect human communities and capital improvements by reducing the intensity and rate of spread of a fire, affording control actions with a higher probability of success and providing safer conditions for firefighters. By removing or reducing the understory and ladder fuels to meet those objectives, dense horizontal cover important to snowshoe hares is reduced and habitat value is diminished for hares and lynx.

Loss, Degradation and Fragmentation of Boreal Forest Habitat - Forest management rarely results in conversion of lands to non-forest. In fact, forested landscapes have increased in some parts of the DPS (especially in the Northeast) because of farm abandonment and recolonization by second-growth forest. However, some forms of forest management such as selective harvesting and fire suppression can intentionally (or not) alter tree species composition away from boreal forest types that support snowshoe hare and lynx. Similarly, lack of forest management can alter tree species composition (Trani *et al.* 2001, pp. 415-417). Other stressors, such as insects and climate change, can work in synergy with forest management to reduce boreal forest. For example, in northern New England clearcutting leads to drying of the

forest floor and consequent heavy mortality in spruce and fir regeneration and increased light levels that increase hardwood competition (White and Cogbill in Eagar and Adams 2012, p. 32).

Plantations can convert native forest communities into monocultures of a native or exotic tree species that may lack hardwood browse for snowshoe hare. Cutting rotation can be reduced by half through mechanical site preparation, planting, and suppression of hardwood competition. Conifer stem densities in plantations range from 800-5,000 stems/ha and may support relatively low populations of snowshoe hares because of the initial wide spacing of trees (Bellefeuille *et al.* 2001, p. 44). Hare densities may increase after trees in a plantation reach the sapling stage and branches intermingle at the ground level creating horizontal cover if the lateral branches are not pruned (Parker 1984, p. 163, Parker 1986 p. 160, Roy *et al.* 2010, p. 285). However, the period of time that spruce plantations may support high hare densities in Maine and eastern Canada may be relatively short (10 to 17 years post-harvest) compared to regenerating softwood clearcuts (15-35 years post-harvest)(Simons-Legaard *et al.* 2013, p. 569).

Under certain forest stand conditions, herbicide treatment may have long-term effects on stand composition and structure (MacLean and Morgan 1983, Daggett 2003), thus reducing food, cover, and habitat for hares (Borrecco 1976, Bellefeuille *et al.* 2001, p. 43, Thompson *et al.* 2003 p. 462). Understory deciduous stems were lacking in stands treated with herbicide (Homyack *et al.* 2004). Although herbicide treatments reportedly do not directly affect survival, fecundity, or other demographic parameters of snowshoe hares (Sullivan 1996), treatments have indirect effects on hares via changes in vegetative cover and browse (Homyack *et al.* 2005, p. 10). In Norway, hares use of plantations was reduced up to 10 years after herbicide application (Hjeljord *et al.* 1988).

Fragmentation - Lynx achieve highest densities in >100 km2 landscapes having a high percentage of large, contiguous patches of high quality hare habitat (Simons 2009, Simons-Legaard *et al.* 2013). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges, by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that land-scapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Forest management can fragment and isolate patches of high quality hare habitat (Simons-Legaard *et al.* 2016). In an intensively managed landscape, lynx habitat is described as a shifting mosaic of patches of habitat suitable to support the needs of resident lynx (FR 74(36)). Fragmentation of the naturally patchy pattern of lynx habitat in the contiguous U.S. can affect

lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation from forest management can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. For example, in Maine the proliferation of partial harvesting will actually increase the patches of high quality hare habitat by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6).

Changes in Frequency and Pattern of Disturbance Events - Prior to European settlement, the dominant natural disturbance processes that created early-successional stages within the range of the lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of the Northeast Geographic Unit, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S.

Today, forest management is the predominant form of disturbance in boreal forest types throughout the DPS, but in the West insect outbreak or wildfire are also critical agents of disturbance that influence and interact with forest management. Throughout the DPS, the frequency of harvesting accelerates in response to salvaging insect damaged stands. In some instances, forest management has greatly altered the disturbance regime. For example, the Acadian forest in Maine and eastern Canada was driven by gap dynamics (similar to some parts of the West today) and true stand-replacing disturbances were quite uncommon with recurrent intervals of thousands of years. After several centuries of forest management, stand age structures have become simplified, and commercial timber rotations are a fraction (15 to 40 percent) of the lifespan of boreal tree species (Seymour 2002). Whereas prevalent, these younger even-aged forest stands on the landscape may benefit hares and lynx in Maine, forestry has shifted the species composition of Maine's forest to species favored by frequent harvest disturbance, such as red-maple, paper birch, aspen, and balsam fir.

3.4 Wildland Fire Management

Wildfire is a natural and essential component of boreal and montane forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger *et al.* 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Wildfire creates and maintains lynx habitats by providing periodic vegetation disturbances that result in the spatial and temporal distribution of early-successional forest stands or patches within older stands featuring dense horizontal cover at ground and snow level. These stands/patches provide high-quality hare foraging habitat and typically support high densities of hares, which in turn provide high-quality lynx foraging habitat.

They are generated by (1) high-intensity, stand-replacing fires that result initially in removal of all or most vegetation, followed by regeneration of dense horizontal cover, or (2) low- or moderate-intensity fires that stimulate understory development in older stands without killing all the overstory, resulting in patches of dense horizontal cover within multi-storied stands (Agee 2000, p. 53; Ruediger *et al.* 2000, p. 7-6). These habitats become most favorable for hares and lynx when regenerating conifers grow tall enough to protrude above the snow, providing cover and food for hares throughout the winter (ILBT 2013, pp. 10-12). They remain important as winter foraging habitat, which may be the most limiting habitat for lynx (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 17, 27), until they reach the stem-exclusion structural stage and self-pruning results in the loss of dense horizontal cover above the snow, or until another disturbance resets them to the stand-initiation structural stage (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 1-3; ILBT 2013, p. 27). The length of time to achieve favorable hare and lynx habitat after fire (or other vegetation disturbance) and the duration for which those conditions persist vary across the lynx range depending on soil and vegetation potential, temperature and precipitation patterns, topography, fire intensity, and perhaps other local conditions (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 2-5; ILBT 2013, pp. 27-29, 75). Generally, regenerating forests in the DPS range may begin providing winter hare habitat within 10-20 years after fire or other disturbance, with favorable conditions persisting for 20-30 years after that (Koehler and Aubry 1994, pp. 86-87; Agee 2000, pp. 67-71; Fuller *et al.* 2007, p. 1985; McCann and Moen 2011, p. 515; Vashon *et al.* 2012, p. 15; ILBT 2013, pp. 28-29), although it may take longer, perhaps 35-40 years, for lynx habitat to recover in some parts of the range (e.g., Maletzke *in* Lynx SSA 2016, p. 21).

Fire frequency, size, intensity, and return intervals also vary across the range of the lynx and depend on localized vegetation communities, climatic conditions, and topography (Agee 2000, pp. 47-56; Ruediger *et al.* 2000, p. 4-8; ILBT 2013, pp. 75-76). In lynx habitats, fire intensity is typically high and fire return intervals long but variable, with large areas affected by infrequent stand-replacing fires and, in mixed fire regimes, moderate- or low-intensity fires in the intervals between stand-replacing events (Agee 2000, pp. 49-54; Ruediger *et al.* 2000, pp. 4-8, 7-6). Within the DPS range, fire return intervals in the Great Lakes Region appear similar to those in the core of the lynx's range in the Canadian and Alaskan taiga (roughly 50-150 years), with longer return intervals in Western (150-300 years) and Northeastern (up to 500 years) U.S. forests (Agee 2000, pp. 52-53; ILBT 2013, pp. 75-76). Despite these long intervals, fire is the dominant natural disturbance mechanism in lynx habitats in the DPS range except in the Northeast, where insects and wind are more important (Agee 2000, p. 53).

Current federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI *et al.* 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Ca kin *et al.* 2015, pp. 1-3) which, combined with other land-use practices, dramatically altered fire regimes in some places and created conditions prone to larger and more severe fires (USDI *et al.* 2001, p. 1-2). Because of (1) fire's important role in creating and maintaining high-quality early-successional hare habitat in most lynx habitats in the contiguous

U.S., (2) the potential for fire suppression to alter this dynamic to the detriment of hares and lynx, and (3) the limited ability of land managers (at that time) to use fire to benefit hares and lynx, wildland fire management was identified as a "Lynx Risk Factor Affecting Lynx Productivity" (Ruediger *et al.* 2000, pp. 2-5, 5-2). To address these concerns, the authors developed objectives, standards, and guidelines for federal land managers to restore fire's role in maintaining lynx habitats, attempt to mimic historic natural fire regimes, and integrate lynx habitat objectives into fire management plans (Ruediger *et al.* 2000, pp. 7-6 - 7-8). They also directed federal land managers to evaluate whether fire suppression or other management practices had altered fire regimes and ecosystem function in potential lynx habitats and, where so, to use fire (naturally ignited fires or prescribed burns) as a tool to restore and maintain lynx habitat by creating or regenerating snowshoe hare habitat (Ruediger *et al.* 2000, p. 7-7).

In its 2000 listing rule and 2003 remanded determination, the Service recognized the potential for fire suppression to adversely affect lynx and hare habitats at local and regional scales, particularly in the Great Lakes Region, where fire suppression policies across land ownerships l kely prevented fire from assuming its natural role in creating a landscape mosaic of vegetation communities and age classes (65 FR 16076; 68 FR 40095). In the Northeast, the Service concluded that the very long fire return intervals and maritime influence in lynx forest types indicated that fire did not historically play a significant role in creating or maintaining lynx and hare habitats and, thus, fire suppression was unl kely to have affected lynx habitat (68 FR 40094). In the West, the Service concluded that the effects of fire suppression were likely lower in lynx forest types because of their typically long fire return intervals compared to lower and drier forest types (65 FR 16074; 68 FR 40093-94). Overall, the Service concluded that fire suppression did not represent a threat to lynx in the Northeast and was a low-magnitude threat in Great Lakes, S. Rockies, and N. Rockies/Cascades (65 FR 16075-16076; 68 FR 40093-40098).

In response to the guidance provided in the LCAS, the USFS, when developing the NRLMD and the SRLA to amend forest plans to address lynx conservation (see 3.1.1, above), evaluated whether fire suppression had adversely affected potential lynx habitats on national forests in the Northern and Southern Rockies. The USFS concluded that many forests in potential lynx habitat are in Condition Class 1, which means they have not missed a fire cycle because large, stand-replacing fire only occurs every 100 to 200 years; the long fire return interval has not been affected to any large degree by more recent fire suppression as is the case in drier forests with short fire return intervals; and they are close to historic conditions (USFS 2007, pp. 18, 20; USFS 2008, p. 11). In addition to the national forests covered by the NRLMD and SRLA (all national forests in the Northwestern Montana/Northeastern Idaho, GYA, and Western Colorado SSA units), the Superior National Forest, which accounts for 45 percent of the Northeastern Minnesota unit, revised its forest plan to adopt lynx conservation measures consistent with the LCAS (USFS 2004, Appendix E). The Okanogan-Wenatchee National Forest in the North-central Washington unit is currently revising its management plan and continues to manage for lynx conservation in accordance with the LCAS, including direction to restore fire to its natural ecological role and to use it as a tool to restore and maintain hare and lynx habitats.

As described above in section 3.1.1, current federal management on most USFS and BLM lands, in accordance with formally revised or amended management plans, includes limits on the proportion of lynx habitat within LAUs that can be in an unsuitable condition at any given time, including such conditions, usually temporary, created by wildfire. Although some exemptions and exceptions to these limits are permitted for activities to reduce fire risks to communities and infrastructure in the wildland-urban interface (WUI) or to achieve other resource benefits, even these potential impacts are limited on the larger landscape scale (USFWS 2007, p. 7). These conservation measures and the direction to use fire management as a tool to restore hare and lynx habitats and return to natural temporal and spatial patterns of fire disturbance, which were not in place when the DPS was listed, likely further reduce what was even then considered the low potential threat to lynx of past fire suppression activities. Based on the information above, we conclude that fire suppression and other fire management activities have not substantially impacted lynx and hare habitats in the DPS range and are unlikely to do so in the future.

However, warming temperatures attributed to climate change are reducing snowpack, causing earlier snowmelt and longer and more extensive droughts, resulting in longer wildfire seasons and increased fire frequency, size, and intensity in boreal forests of the north and in boreal and montane forests in some parts of the DPS range (Weber and Flannigan 1997, entire; Stocks *et al.* 1998, entire; Gillett *et al.* 2004, entire; Kasischke and Turetsky 2006, entire; Soja *et al.* 2007, entire; Pierce *et al.* 2008, entire; Flannigan *et al.* 2009, entire; Krawchuk *et al.* 2009, entire; Le Goff *et al.* 2009, entire; Bergeron *et al.* 2010, entire; Salathe *et al.* 2010, entire; Abatzoglou 2011, entire; McKelvey *et al.* 2011, entire; Abatzoglou and Kolden 2013, entire; Pederson *et al.* 2013, p. 1815; Price *et al.* 2013, pp. 342-343, 352-354; Barbero *et al.* 2014, entire; Trenberth *et al.* 2014, entire; Barbero *et al.* 2015, entire; Jolly *et al.* 2015, entire; Lute *et al.* 2015, entire; USEPA 2015, entire; Lienard *et al.* 2016, entire; Littell *et al.* 2016, entire; Westerling 2016, entire; see also section 3.2 above). Increases in fire frequency and size have the potential to adversely affect lynx and hare habitats in the DPS range by rapidly converting large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats (ILBT 2013, p. 70). Although this would likely be a temporary impact, with burned areas subsequently regenerating into higher-quality habitat, it would likely reduce landscape-level hare densities and, therefore, lynx numbers, potentially compromising an area's ability to support a resident lynx population until burned habitats recover.

Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already naturally marginal in many parts of the DPS range, it is possible that very large wildfires or many over a short time period could, perhaps in concert with other influencing factors, tip an area from just barely capable of supporting a resident lynx population to no longer capable of doing so, resulting in extirpation. For example, multiple large fires in north-central Washington over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). It may take 35-40 years for these areas to

recover as lynx and hare habitat (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and other habitat impacts could further diminish habitat availability and the lynx population's probability of persistence (Lewis 2016, pp. 5-6; Lynx SSA Team 2016, p. 44; also see section 2.3.2.2, above, and sections 4.1.4 and 5.1.4, below). The loss of habitat resulting from these fires and its potential demographic impacts on the State's only resident lynx population contributed substantially to the Washington Department of Fish and Wildlife's recent recommendation to uplist lynx from threatened to endangered under its State Endangered Species Program (Lewis 2016, entire).

Wildfire frequency, size, and intensity have also increased in the Northwestern Montana/ Northeastern Idaho geographic unit, where about 4,172 km^2 (1,611 mi^2; over 15 percent of the unit) have burned in western Montana from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20). Large fires have also impacted lynx habitat in the Western Colorado geographic unit, where fire size, frequency, and intensity are expected to increase with climate change (Ivan *in* Lynx SSA Team 2016, p. 23). As mentioned in section 2.3.2.2, large areas of the GYA unit were burned by the extensive wildfires of 1988. The extent to which those fires may have diminished lynx and hare habitats and contributed to the recent absence of resident lynx is uncertain, as is the potential for those burned areas to support high hare densities and resident lynx in the future. However, some burned areas may soon develop the dense horizontal conifer structure favorable for hares and, therefore, for lynx foraging habitat, perhaps increasing the likelihood that they may support resident lynx in the near future.

Although fire suppression was in the past thought to be a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

3.5 Habitat Loss and Fragmentation

Boreal forest habitats in the DPS are patchy and marginal for both snowshoe hares and Canada lynx. In this region, boreal forest transitions to various types of northern hardwood forest. The transitional nature of the boreal forest at its southern extent is believed (along with competition from other hare predators) to limit the numbers of both hares and lynx, preventing either from regularly achieving densities comparable to those regularly achieved in the classic boreal forests at the centers of their ranges in north-central Canada and Alaska (79 FR 54790). Lynx must contend with aspects of their habitat at the southern extent of the boreal forest for which they are not as well-adapted.

Fragmentation has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991). "Patchiness" is sometimes used to refer to natural processes (Buskirk *et al.* 2000a, p. 85), whereas and "fragmentation" to anthropogenic disruption of natural patterns. Habitat loss is conversion of forest to another land use or vegetative cover.

Forest loss and fragmentation are relatively low in the DPS compared to other forested regions in the United States (Heilman *et al.* 2002, p. 416). Since 2000 in the western United States, land uses associated with residential development, roads, and highway traffic have resulted in a 4.5% loss in area (20,000 km^2) of forest, and continued expansion of residential development will likely reduce forested patches by another 1.2% by 2030 (Theobold *et al.* 2011 (entire). Fragmentation in the forested western landscape resulted in a decline of weighted mean patch size from roughly 35,000 to 3,200 km^2 from natural to current conditions, but models predict relatively small declines in the size of forested patches over the next 30 years (Theobold *et al.* 2011 p. 2451). In the eastern United States, nearly half or more of the natural forest was cleared in the past three centuries but as agriculture and settlement relocated westward, eastern forest cover rebounded (Williams 1989, Smith *et al.* 2005). Maine's forest area has increased 0.79 percent since 1982 (Maine Forest Service, Department of Conservation 2010, p. 25). Similarly, a large portion of Minnesota forests were cleared in the last century, but forest cover has rebounded. The forest area in northern Minnesota has decreased 4 percent since 1977 (Miles *et al.* 2007, p. 22). Preliminary findings from the 2002 U.S. timber assessment (Haynes 2003) indicate that approximately 15 to 20 million acres of U.S. forest land could be converted to urban and developed uses over the next 50 years. Such land use conversions could result from residential development in forested landscapes, as the U.S. population is estimated to grow by another 126 million people.

Habitat fragmentation (both natural and anthropomorphic) directly affects snowshoe hares and lynx by various mechanisms; reducing hare survival and landscape hare densities, increasing lynx home ranges, reducing lynx reproduction and survival, and affecting lynx movements throughout the landscape. Habitat fragmentation also influences mesocarnivore communities that coexist with lynx and the level of competition for space and food resources. Fragmentation from anthropomorphic sources results in habitat alteration, direct habitat loss, vehicle collisions and behavioral disturbance from roads, and changes in landscape features such as edges.

Landscapes in which hare habitat is more contiguous, or where good patches of hare habitat are surrounded by other patches of similar habitat quality, support more hares than landscapes that are more fragmented or include matrix habitats that are poorer quality (Lewis *et al.* 2011, p. 565). Thus, southern transitional boreal forests generally have lower landscape snowshoe hare densities than boreal forests further north (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84). This may have as much to do with the quality of the matrix habitat between high quality patches as the hare densities that occur in the high quality patches themselves (Lewis *et al.* 2011). Low-quality matrix habitat, typical throughout much of the DPS, could decrease survival for hares, because predators might have higher hunting success or be more numerous in the matrix habitats (Griffin and Mills 2009). In contrast, a high-quality matrix, typical of Canadian boreal forest, can provide alternative or supplemental resources (Dunning *et al.* 1992; Norton *et al.* 2000), thus supporting higher densities of hares in the prime habitats.

The patchy distribution of hares and differences between landscape hare densities in the contiguous United States require lynx in most areas to incorporate more land area into their home ranges than lynx do in the north to acquire adequate food (Mowat *et al.* 2000, pp. 265, 277–278). At some point, landscape hare densities become too low, making some areas incapable of supporting lynx. Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range.

Throughout the northern part of their range, snowshoe hares are found in continuous areas of boreal forest; conversely, southern populations occur primarily in insular patches of suitable habitat set amidst less-preferred areas (Wolff 1980; Keith *et al.* 1993). This disparity has led a number of biologists to speculate that habitat fragmentation may be ultimately responsible for the non-cycling nature of snowshoe hare populations in the northern U. S. and southern Canada (Dolbeer and Clark 1975; Buehler and Keith 1982; Keith *et al.* 1993, Strohm and Tyson 2009). Wolff (1980, 1981) described the mechanism by which a fragmented habitat might dampen or eliminate cyclic population fluctuations.

Forest fragmentation may exacerbate competition between lynx and other predators (Buskirk *et al.* 2000a, entire). Fragmentation and competition are strongly linked because vegetation mosaics in landscapes provide high quality environments for generalist species such as the bobcat, red fox, and coyote (Goodrich and Buskirk 1995, Buskirk *et al.* 2000a, p. 84). Under such conditions, generalist predators tend to dominate the predator guild in fragmented landscapes (Oehler and Litvaitis 1996). Hares fluctuate less dramatically in the southern part of the range of lynx, thus there is more competition for a limited resource and exploitation competition inflicted by generalists (e.g., coyotes) and other predators (Buskirk *et al.* 2000a, p. 95).

Snowshoe hares in the south are concentrated in isolated patches of suitable habitat and subject to predation by a suite of generalist predators (e.g., Litvaitis *et al.* 1985; Sievert and Keith 1985; Keith *et al.* 1993; Cox *et al.* 1997). Keith *et al.* (1993) found that extremely high predation rate on hare living in high quality hare habitats, rather than predation on naturally dispersing individuals, seemed to be driving the changes in distribution and abundance in a snowshoe hare population in Wisconsin. In this study, predation pressure on populations occupying small (<7 ha) patches of preferred habitat was so severe that 3 of the 5 populations under investigation went extinct in the course of the 3-year study. Fragmentation of landscapes exacerbate the effect of predation by allowing carnivores to concentrate their hunting efforts on small patches of habitat used by their preferred prey instead of preying disproportionately on dispersing individuals (Wirsing *et al.* 2003, p. 170). In predator-rich landscapes characteristic of the DPS, this can result in intense predation and competition for a limited prey resource.

Lynx seem to be flexible in their response to habitat fragmentation whereas closely related species, such as bobcats and Iberian lynx, are sensitive to habitat fragmentation (Ferreras 2001, Crooks 2002). In a southern Ontario landscape Hornseth *et al.* 2014 (pp. 8-9) demonstrated that lynx exhibited a wide range of responses to habitat alteration. In general, lynx

responded most positively to areas having greater than 50 percent suitable habitat and generally avoided areas having less than 30 percent suitable habitat. However, lynx showed no sensitivity to the degree of forest fragmentation in areas of high or low suitable habitat.

All of these factors likely lead to lower reproductive output and more tenuous conservation status for lynx in many parts of the DPS relative to those in Canada and Alaska (Buskirk *et al.* 2000a, p. 95). Thus, factors that further fragment boreal forests in the DPS (e.g., climate change, forest management, roads and development) further reduce the probability of persistence of lynx.

The snow environment in the DPS is also patchy and marginal in both space and time for snowshoe hares and Canada lynx. Snow depth (Hoving *et al.* 2005, Peers *et al.* 2013, entire) and duration (Gonzales *et al.* 2007) give lynx a competitive advantage over generalist predators in the conterminous United States. Too little snow or crusting conditions favor competitors and predators like bobcat, fisher, and coyotes. High elevations may provide snow conditions that favor lynx, whereas low elevations favor conditions for competitors. Lynx may have competitive advantage at higher elevations in the DPS in the winter, but not in summer months when competitors may have free access to all habitats. In contrast, extensive deep, fluffy snow conditions favor lynx in broad areas of north-central Canada and Alaska.

Landscape features further fragment hare and lynx habitat. In lynx units in the western contiguous U.S., potentially suitable boreal forests and appropriate snow conditions occur in relatively narrow elevational bands in the Cascade and Northern and Southern Rocky mountains. Thus, appropriate habitats for lynx are naturally fragmented by topography and vegetation gradients. These “islands” of habitat can be extensive (e.g., the Okanagan in Washington or most of northwestern Montana) or smaller and relatively isolated (e.g., the Garnet Range in western Montana) depending on topography and precipitation patterns. Some of these areas of boreal forest are separated by unsuitable habitats in the low valleys (e.g., sage flats, urban corridors, agricultural lands) or by snow regimes (e.g. snow shadows) that may restrict lynx dispersal between habitat patches. In some western parts of the DPS range, lynx habitat in is also fragmented by rugged, high elevation terrain (Carroll *et al.* 2001, p. 976). In other areas of the DPS where there is little topography, including Minnesota and Maine, matrix forest facilitates lynx movements between suitable habitats. Large rivers are unlikely to fragment habitat as lynx readily swim across large bodies of water (Feierabend and Kielland 2014, entire) or cross them on ice in the winter (Koen *et al.* 2015).

Snow is an important component of lynx habitat (79 FR 54809). Snowfall can be patchily-distributed, variable and unpredictable from year to year, and affected by local topography, water bodies, and climate gradients. Snow conditions that provide lynx a competitive advantage over other terrestrial hare predators are most consistent in the high-elevation regions of the western U.S., although snow alone does not constitute lynx habitat (i.e., many places receive sufficient snow but lack other features lynx need, typically adequate hare densities). Snow conditions are less consistent in the East. For example, lake-effect snow from Lake Superior can increase snow depth and duration in the Arrowhead region of Minnesota in some years, but

not others. The Gulf of Maine has the reverse effect, and its warming influence reduces snow depth and duration inland. Distr bution models by Hoving (2001, p. 74) indicate that eastern Maine has extensive areas of boreal forest but does not achieve snowfall thresholds that gave lynx an advantage over bobcats and other competitors.

Lynx populations are clearly most viable in areas having extensive, unfragmented boreal forest habitats with large patches of high-quality foraging habitat and persistent deep, fluffy snow. Both lynx and hares are influenced by the spatial arrangement of preferred habitat. In Ontario, lynx preferred habitats with a high degree of connectivity (Walpole *et al.* 2012, p. 769). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Several studies (Koehler 1990a, Mowat *et al.* 2000, von Kienast 2003, Maletzke 2004, Squires and Ruggiero 2007, Squires *et al.* 2010) have reported that lynx avoid large openings, especially during winter. Mowat *et al.* (2000) suggested that relatively few snowshoe hares use large openings, and consequently lynx spend little time hunting in these areas. Koehler (1990a) speculated that vegetation management prescriptions that result in distance to cover >100 m (328 ft) may change lynx movement and use patterns until such time as sufficient reestablishment of forest vegetation occurs. Opening size can also influence seedling regeneration and stocking densities (Kreyling *et al.* 2008).

Similarly, individual lynx have the smallest home ranges and greatest survival and productivity in landscapes that have extensive, large patches of habitat in combination with deep, fluffy snow. Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that landscapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Anthropogenic Sources of Fragmentation - Human activities can exacerbate the natural habitat fragmentation that is typical throughout much of the DPS range. Anthropogenic activities such as forest management, development, and highways alter natural landscape patterns. They cumulatively can reduce the total area of habitat, diminish the quality of habitat, increase the isolation of habitat patches, and impair the ability of lynx and other wildlife to effectively move between patches of habitat. Anthropogenic fragmentation may be permanent, for example by converting forest habitat to residential, industrial, or agricultural purposes, or temporary, for example by conducting forest management but allowing trees and shrubs to regrow. Habitat fragmentation (both natural and anthropogenic) increases the risk of extirpation of small lynx populations.

Human-caused fragmentation of the already naturally patchy pattern of lynx habitat in the contiguous U.S. can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. Maintaining a mosaic of large (>100 acres) patches of young to old stands in patterns that are representative of natural ecological processes and disturbance regimes would be conducive to long-term conservation of lynx (ILBT 2013, p. 77).

Roads, development, climate change, and forest management fragment snowshoe hare and lynx habitat in the DPS. We know little about how hare and lynx respond to these anthropomorphic changes to their habitat, which requires additional research (Murray *et al.* 2008, p. 1464; Squires *et al.* 2013, p. 194). In the next decades, southern lynx populations will incur further habitat loss and fragmentation and the effects of climate change. Changes in habitat, prey base, and competitor guild will further stress southern lynx populations and possibly populations in southern Canada. Ultimately, the extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in its current southern range (Murray *et al.* 2008, p. 1469).

Roads - Paved highways fragment lynx habitat. In the West, they typically follow natural features such as rivers, valleys, and mountain passes that may have high value for lynx in providing habitat or connectivity. They surround large blocks of lynx habitat in Minnesota and northern Maine. Various studies have documented lynx crossings of highways. A male lynx in western Wyoming was documented to have successfully crossed several 2-lane highways during exploratory movements (Squires and Oakleaf 2005). However, in Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx (Bayne *et al.* 2008). Apps *et al.* (2007) found lynx were 13 times less likely to cross the Trans-Canada Highway relative to random expectation, but only 2.2 and 3.1 times less likely to cross smaller highways (93 and 1A, respectively). In southeastern British Columbia, lynx avoided crossing highways within their home ranges (Apps, 2000). Squires *et al.* 2013 (p. 194) documented 44 radio-collared lynx with home ranges within an 8 km buffer of 2-lane highways, however, only 12 of these individuals crossed the highway (Squires, unpublished data).

Paved highways also pose a risk of direct mortality to lynx and may inhibit lynx movement between previously connected habitats. If lynx avoid crossing highways, this could lead to a loss of effective habitat within a home range and reduced interaction within a local population (Apps *et al.* 2007). Lynx and other carnivores may avoid using habitat adjacent to highways, or become intimidated by highway traffic when attempting to cross (Gibeau and Heuer 1996, Forman and Alexander 1998).

Carnivores are especially vulnerable to highway-caused mortality in areas with dense and high traffic volume roadways (Clevenger *et al.* , 2001). As the standard of roads increases from gravel to 2-lane or 4-lane highways, traffic volumes and the degree of impact are expected to increase. Walpole *et al.* (2012, p. 770) found that small logging roads with low traffic volume had no effect on lynx distribution. Four-lane highways, such as the interstate highway system, commonly have fences on both sides, service roads, parallel railroads or power lines, and impediments like "Jersey barriers" that make successful crossing more difficult, or impossible, for wildlife (ILBT 2013, p. 78). Alexander *et al.* (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. In Colorado, lynx successfully and repeatedly crossed major highways, including I-70 (J.Squires, personal communication 2012; Ivan 2011b, c, 2012). Colorado lynx crossed two-lane highways an average of 0.6 times per day and more frequently during dusk and night when traffic volume was lower (Baigas *et al.* 2017, p. 204). They also crossed 4-lane highways (I-70), especially forested areas under large, elevated bridges that spanned streams (Baigas *et al.* 2017, p. 204).

Between 2000 and 2015, 54 lynx were reported to have been killed on roads (both paved and unpaved) in Maine (J. Vashon, Maine Department of Inland Fisheries and Wildlife, unpub. data), 11 in Minnesota (T. Smith, U. S. Fish and Wildlife Service, unpub. data), 1 in Idaho and 5 in Montana (compiled by K. Broderdorp, U.S. Fish and Wildlife Service, unpub. data 2016). Between 1995 and 2011, 15 lynx were reported killed on British Columbia highways (British Columbia Wildlife Accident Reporting System 2012). Most of these mortalities are on higher speed paved highways. However, in Maine, about 41 percent (22 of 54) were killed on lower speed dirt logging roads.

Translocated animals may be more vulnerable to highway mortality than resident lynx (Brocke *et al.* 1990), because they often move extensively after their release and are unfamiliar with their surroundings. In the Adirondack Mountains of New York, an attempt to reintroduce lynx failed and 18 of 37 mortalities of translocated animals were attributed to road kills (Brocke *et al.* 1990). Over a 7-year period in Colorado, 13 of 102 documented mortalities of translocated lynx were killed on highways (Devineau *et al.* 2010). Traffic volumes on Colorado highways where the 13 lynx mortalities occurred were estimated to range from about 2,300 to >25,000 vehicles per day (K. Broderdorp, personal communication 2012).

Roads of all sizes have many indirect effects to lynx including increased human access (e.g. trapping and illegal shooting), and creating edge habitats that promote co-occurrence with competitors like coyotes and bobcats (Bayne *et al.* 2008, p. 1195).

Vegetation Management - As described in section 3.3, above, forest management can further fragment boreal forest in the northern contiguous United States affecting habitat suitability for both snowshoe hares and lynx. Large-scale forest fragmentation or maturation can be deleterious to snowshoe hares because they become increasingly restricted to small patches with adequate cover, and higher predation rates from a variety of carnivores tend to increase

local extinction risk (Wolff 1981, Keith *et al.* 1993, Wirsing *et al.* 2002; see also Barbour and Litvaitis 1993).

Although some forest management can benefit lynx by creating or maintaining a shifting mosaic of lynx habitat, it can also be detrimental by fragmenting habitat into small, widely-spaced parcels. Changes to vegetation structure can increase landscape resistance to lynx movements (Squires *et al.* 2013). In Montana, fragmentation from forest thinning decreased the probability of lynx movements across the forested landscape (Squires *et al.* 2013, p. 192). Lynx in the Northern Rockies are sensitive to changes in forest structure and tend to avoid large forest openings (Koehler, 1990; Squires *et al.* , 2010) like recent clearcuts and thinned areas. In Maine, the shift to partial harvesting forms of forest management will continue to increase the number of patches of high quality hare habitat, but it will greatly reduce the size of patches and increase their isolation (Simons-Legaard *et al.* 2016, pp. 5-6). This is diminishing landscape conditions conducive to supporting lynx.

Residential and Commercial Development - Residential and commercial development is increasing on private forest lands. Increased traffic and urbanization are projected for the Northern Rockies (Hansen *et al.* 2002) and Maine (section 5.1.1). It is uncertain to what degree lynx can tolerate habitat fragmentation from roads and forest clearing, and how human and pet activity affect lynx use of habitats. Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat *et al.* 2000). The degree to which residential development and associated roads reduce connectivity of mesocarnivore populations (including lynx) likely depends on the physical design of highway improvements, the surrounding environmental features, the density of increased urbanization, and the increased traffic volume (Clevenger and Waltho, 2005; Grilo *et al.* 2009).

Ski Resorts - Ski areas have similar effects on permanent habitat loss and fragmentation. One ski run is often separated from the next only by small inter-trail forest islands. Ski runs often are intermixed with other open areas such as open or gladed bowls, rock outcrops, or barren tundra ridges. Ski resorts that are built or expanded in lynx habitat may impact lynx by removing forest cover, reducing the snowshoe hare prey base, and creating or increasing human disturbance in or near linkage areas. There is limited information on lynx behavior and habitat use in and around ski areas. Lynx have been known to incorporate smaller ski resorts within their home ranges, but may not utilize the large resorts. Preliminary information from an ongoing study in Colorado suggests that some recreational use may be compatible, but lynx may avoid some areas with concentrated recreation use. In some areas, lynx habitat may be limited and concentrated in the ski area development footprint (J. Squires, personal communication 2012).

More than 50 ski areas exist throughout the range of the lynx in the contiguous U.S. (ILBT 2013, pp. 82-83). Most ski areas are located on north-facing slopes, where ample snow conditions provide for extended ski/snowboard recreational seasons. In the western states, many of these landscapes feature spruce-fir forests. While ski resorts occupy a small proportion of the landscape, spruce-fir forests provide important habitat for snowshoe hares and lynx at the

southern extent of their range. In winter, alpine and Nordic skiing and snowboarding are the primary uses. Most of these resorts offer year-round recreation, with summer activities typically including h king and mountain biking.

Mining Leasable Minerals - Activities associated with exploration and development of leasable minerals occur primarily in western units of the DPS. Very little mining development occurs in Minnesota and northern Maine. Mining affects lynx habitat by changing or eliminating the native vegetation, human disturbance, and contributes to habitat fragmentation. Development of a high density of wells, as is typical of coal-bed methane development (e.g., 1 well per 2–4 ha [5–10 ac]), could affect lynx by directly removing habitat or causing sufficient human presence to displace lynx. The development of associated roads, powerlines, and pipelines to facilitate exploration and development also result in a loss of lynx habitat and contribute to fragmentation of habitat. In some areas, for example in the Wyoming Range, extensive oil and gas development is occurring within lynx habitat.

Locatable Minerals - Only a fraction of the historical number of mines is operating today. Those that continue to operate do so with more stringent environmental protection measures. However, in some parts of the United States, minerals exploration and new development seem to be increasing. Activities associated with exploration and development of locatable minerals could affect lynx habitat by changing or eliminating the native vegetation, and by contributing to habitat fragmentation. The effects can be variable depending on the size of the associated mining operation or development. Locatable minerals are extracted through both open pit and sub-surface mines with potential habitat alteration ranging from tens to thousands of hectares. In some instances, such as larger mining operations, land exchanges are conducted to consolidate private ownership of the surface above a deposit prior to mine development. Depending on lands exchanged this could retain lynx habitat in public ownership, but could still result in a net loss of habitat. Development of road and railroad access to facilitate exploration and development also directly impact lynx habitat, contribute to fragmentation, facilitate increased competition as a result of snow-compacted routes, and result in direct mortality. Despite these potential effects, mining exploration and development is generally anticipated to affect only a small portion of lynx habitat in the contiguous United States.

Salable Minerals - In general, salable minerals are found close to the surface. During exploration activities, equipment is moved to the site and a number of test pits are dug or holes drilled to determine the quality of material. If desired minerals are found in suitable quantity, then vegetation is removed and materials are excavated. For example, gravel pits are needed for logging road development and maintenance and are common occurrences throughout areas of the DPS that are in active forest management. Areas developed for salable minerals can vary in size from a single truck load to tens of acres. Impacts to lynx include the potential alteration or removal of lynx habitat, increased fragmentation, and the potential for human-caused mortality from road development.

Wind Energy - Wind energy development and associated transmission lines in lynx habitat is increasing across the nation. Facilities are located on ridge tops or other areas exposed to

consistent wind. The construction of wind facilities including access roads may result in loss of lynx habitat and increased fragmentation from permanent forest clearings. Noise and human activity associated with the construction and operation of wind facilities could disturb or displace lynx from important habitats. Effects would likely continue through the life of the project, which may exceed 20 years.

Utility Corridors - Utility corridors contain developments such as overhead or buried powerlines and gas pipelines, and often are located within or adjacent to existing road rights-of-way. Utility corridors potentially could have short- or long-term impacts to lynx habitats, depending on location, type, vegetation clearing standards, and frequency of maintenance. Those that are extensively cleared of vegetation and maintained in grass or herbaceous vegetation likely equate to a permanent habitat loss. When associated with highways and railroads, utility corridors may further widen the right-of-way. Utility corridors may facilitate human access into previously remote areas thus exposing lynx to increased trapping and possible illegal shooting.

Agriculture - Agricultural activity is not expanding currently in lynx habitat areas in the DPS range. In fact, in the late 1800s, over 3 million acres of northern Maine was in farming, compared to about 700,000 acres today (Ahn *et al.* 2002, p. 8). Most of the current farming is in northeastern Maine, where it fragments the forested landscape corridor between core habitats in northern Maine and western New Brunswick, Canada. Forest clearing for agriculture may have contributed (along with increasing road densities and an expansion in coyote distribution) to the recent contraction in the southern part of lynx range in eastern Alberta (Bayne *et al.* 2008, p. 1195).

Habitat Loss and Fragmentation in Corridor Areas Connecting Lynx Populations in the DPS with Adjacent Populations in Canada - Lynx conservation in the contiguous U.S. is thought to depend in part on maintaining connectivity with habitat areas and lynx populations in Canada. Maintaining connectivity for lynx may become increasingly difficult because of climate change and other anthropogenic influences, as evidenced by reduced connectivity for other boreal species (van Oort *et al.* 2011). Potential corridors have been identified in the northern Rockies (Squires *et al.* 2013, entire). There are likely broad, forested corridors with suitable dispersal habitat connecting core habitats in Maine to southern Quebec and northern Minnesota to southern Ontario. Given the perceived importance of lynx immigration from Canada to the persistence of the DPS (FR 68 40076– 40101, Squires *et al.* 2013, p. 187), roads and other forms of habitat loss and fragmentation that may impede lynx movements in the border regions of Canada and the U.S. are of concern.

Chapter 4: Current Conditions

In this chapter, we present our understanding, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the current status of the lynx DPS in terms of redundancy, representation, and resiliency. . We then provide brief summaries of the current conditions in each geographic unit, followed by a more detailed evaluation of the status of lynx populations and habitats and the factors currently believed to

influence them in each unit. Where appropriate, we compare our current understanding to what was known or believed when the DPS was listed under the ESA in 2000 and to our understanding of historical conditions.

4.1 Summary of Current Conditions DPS-wide

Because of the limitations and uncertainty in the historic records of lynx occurrence in the contiguous U.S. (described above in section 2.3.2.1), it is difficult to compare the current distribution and status of resident lynx populations in the DPS with what may have been the historical condition (but see evaluation in section 2.3.2.2, above). However, research and surveys over the last two decades have significantly improved our understanding of the current distribution, habitats, and the status of resident populations compared to what was known when the DPS was listed in 2000. For example, although we knew there were some resident lynx in Maine (Unit 1), we did not have a feel for population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS, that extensive clear-cutting in the 1970s and 1980s in response to a large spruce budworm outbreak has created the current abundance of high-quality lynx habitat, and that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain whether Minnesota (Unit 2) supported a resident population. We now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. (Units 3, 4, 5, and 6) are naturally less abundant and more patchily-distributed than was thought at the time of listing, and several areas thought to have historically supported small resident populations currently do not (the GYA [Unit 5], the Garnet Mountains in western Montana [Unit 3], and the Kettle Mountains of northeastern Washington). We also know that recent extensive wildfires in north-central Washington (Unit 4) have reduced (probably temporarily) the amount of high-quality lynx habitat and likely caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado (Unit 6), although the current number of lynx there is unknown and their distribution uncertain.

With regard to redundancy, defined as the ability of the DPS to withstand catastrophic events, we find that the current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southern Colorado. Resident breeding lynx populations currently occupy five of the six geographic units (all but the GYA; Figure 1). Of the five occupied units, four are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2) (see tables 1, above, and 4, below). Lynx experts indicated no catastrophic event that could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS and, further, no or a very low likelihood of functional extirpation of any of the individual geographic units due to a single catastrophic event (Lynx SSA Team 2016, p. 56).

Because we lack evidence that persistent lynx populations have been lost from any other large geographic areas in the contiguous U.S., it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. That is, the loss of resident lynx populations in the DPS, to the extent suggested by verified historic records, was likely in areas (e.g., northern New Hampshire, Michigan's Upper Peninsula, the Kettle/Wedge area of northeastern Washington, perhaps Isle Royale in Lake Superior) peripheral to the geographic units that currently support resident lynx. Any small populations that were lost were not in large, discrete geographic units that would have represented substantially greater redundancy in the contiguous U.S. However, the implications of the potential recent loss of resident lynx in the GYA for the redundancy of the DPS are unclear. The historic record and recent research show that the GYA has supported resident lynx. However, it is unclear whether the area consistently supported a resident breeding population over time or whether it naturally supported resident lynx only some of the time ("winked on" in a metapopulation sense) when habitat conditions and hare densities were favorable, and at other times, when habitats and hare densities were less favorable, it did not support resident lynx ("winked off" in a metapopulation sense). Given the protected conservation status of millions of -acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. If so, the contribution of the GYA to redundancy within the DPS is questionable.

Representation, defined as the ability of the DPS to adapt to changing environmental conditions, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Lynx experts and geneticists indicated high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Although hybridization with bobcats has been documented in the DPS (in Maine and Minnesota), it is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Further, despite differences in forest community types and other habitat parameters (e.g., topographic/elevation settings) lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Therefore, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. Because there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions, we find that the DPS currently displays an adequate level of representation.

Resiliency, the ability to withstand stochastic disturbance events, is currently exh bited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. However, because we lack reliable estimates of the sizes and

trends of most lynx populations in the DPS, we are unable to use these parameters to evaluate the current resiliency of individual populations or geographic units. Although some demographic data (survival, reproductive rates) are available for each geographic unit (see Table 3, below), they were collected using different methods, at different times and for different intervals, and possibly at different points in hare population cycles or fluctuations and, therefore, do not provide a consistent measure of resiliency. Efforts to understand resiliency within the DPS are also confounded by the metapopulation structure thought to govern lynx populations at the southern margin of their continental range, which suggests that some populations may be naturally ephemeral (i.e., “winked on” when conditions are favorable; “winked off” when conditions are not favorable). The related uncertainty about the extent to which DPS populations may rely on cyclic immigration of lynx from Canada during population irruptions and the ambiguity in the historic record that limits our understanding of the relative persistence of lynx in various geographical areas also limit our ability to characterize, rank, or model the relative contribution of each geographic areas to the resiliency of the DPS.

Despite uncertainties and data deficiencies, qualitative factors provide some hints about current relative resiliency among some geographic areas or parts of them. For example, in Maine, lynx appear to have demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the possible extirpation of lynx populations in the GYA (Unit 5) and in the Garnet Mountains of Unit 3 may indicate the lower level of resiliency expected among small and relatively more isolated populations. The persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population; however, the post-fires increase in home range size and likely decrease in lynx numbers may indicate the population is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Overall, the apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historic conditions suggest adequate historical and recent levels of resiliency of lynx populations in the DPS.

In summary, the lynx DPS currently exhibits adequate redundancy to preclude extirpation as a result of catastrophic events. The genetic health and ecological diversity expressed across the DPS range l kewise suggest a currently adequate level of representation. The long-term persistence and apparent broad geographical distribution of lynx populations in four of the six geographic units also suggests the current adequacy of resiliency in the DPS, although the potential recent extirpation of several small populations may be an indication of inadequate resiliency in those places.

4.1.1 Summaries of Current Conditions in Each Geographic Unit

Unit 1 - Northern Maine: This geographic unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) in northern Maine, but small areas of similar habitat also occur in northern New Hampshire and northern Vermont. Resident lynx in this unit are part of a larger population that also occupies southern Quebec and northern New Brunswick, Canada. At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that the largest reproducing resident population of lynx in the DPS likely occurs in this unit (numbers and trends unknown, but enough habitat exists to support possibly 500 to 1000 lynx). Small numbers of reproducing lynx have also been documented recently in northern New Hampshire and northern Vermont. Historically, lynx distribution in this unit was patchy, and lynx populations were likely low and dependent on immigration from Canada. Forest management is now the primary driver of hare and lynx habitat in this DPS unit. Current lynx and hare habitat is historically high because of young, regenerating softwood forests created by extensive clearcutting and herbiciding to salvage spruce-fir following a severe spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Lynx responded to these conditions with high survival and reproduction, small home ranges, and moderate population densities. State forestry regulations passed in 1989 caused landowners to shift to various forms of partial harvesting that have resulted in lower landscape hare densities across much of the unit. Hares do not seem to cycle in this region, but underwent a 50 percent decline starting in 2006 and have remained at lower levels. Reproduction and survival rates in the low-hare environment suggest a slightly declining population. Unlike other units of the DPS, lynx habitat in northern Maine occurs nearly entirely on private, industrial forest lands, and landowners do not have long-term commitments to lynx management. The majority of lands in Maine are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with hare and lynx habitat. Other potential stressors on private lands include large-scale wind energy development, residential and resort development, and parcelization of forestlands from rapid turnover in investment company landowners. The next spruce budworm outbreak is imminent, but forestry response by investment landowners is uncertain. Climate change is a concern as snow depth and duration are currently at the minimum thresholds believed necessary to give lynx a competitive advantage over bobcats and other mesocarnivores. There is currently no clear evidence of climate change effects on lynx distribution.

Unit 2 - Northeastern Minnesota: This geographic unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps, and black spruce or tamarack bogs. Despite uncertainty when the DPS was listed, it has become apparent that a reproducing resident population of roughly 50 to 200 lynx exists in northeastern Minnesota. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario, where trapping of lynx is legal. Lynx in Minnesota select regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites are associated with regenerating and mixed forest (Burdett 2008, p. 57). Hare densities in parts of northeastern Minnesota appear to be sufficient to support a viable lynx population; and densities

are highest in regenerating forests (McCann and Moen 2011, p. 513). The Superior National Forest continues to manage in accordance with its 2004 Forest Plan, and several risk factors are being minimized and managed to promote the conservation of lynx within the SNF. Management of lynx habitat on state and private lands is voluntary. Factors affecting current conditions in this unit primarily include forestry management, roads, incidental trapping, mining development, snow compaction, competition with bobcats, and lynx-bobcat hybridization. Forty-nine lynx mortalities due to vehicle and train collisions as well as incidental trapping and shooting have been reported in Minnesota since the species was listed.

Unit 3 - Northwestern Montana/Northeastern Idaho: There are no reliable estimates of current or historic resident lynx numbers in this geographic unit, but it is thought to be capable of supporting 200-300 lynx home ranges. Habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Minor genetic differences suggest three subpopulations in the northwest (Purcell Mountains), central (Seeley Lake), and southern (Garnet Mountains) parts of the unit. No lynx have been detected in the Garnets after 2010, but whether this indicates the extirpation of a small (7-10 individuals) previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit, including federal, State, Tribal, and some private lands, is managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire supporession) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx, with the Garnets being a possible exception. Wildfire extent has increased over the past several decades, likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Hare densities have not been estimated broadly throughout the unit but appear to be low or marginal even in most of what is considered the highest-quality habitat, suggesting that even small decreases in habitat quality/hare densities could influence its continued ability to support resident lynx. The role of past and recent immigration in maintaining the demographic and genetic health of current lynx populations in this unit is unknown, but peaks in cyclic lynx numbers in Canada have declined, especially when compared to the unprecedented irruptions of the early 1960s and 1970s, and there is no evidence of significant immigration into this unit since then.

Unit 4 - North-central Washington: This geographic unit encompasses approximately 5,176 km^2 (1,988 mi^2), 91.5 percent federally owned. It contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia, directly north of this unit, and maintaining connectivity with Canada is considered important to maintaining lynx populations in this unit. There are no reliable estimates of current or historic resident lynx numbers in this unit, but recent habitat and home range analyses (summarized in Lewis 2016) suggest that it may have been capable of supporting 65-90 lynx prior to recent large wildfires. Those fires affected about 50 percent of the potential lynx

habitat, led to increased home range size, and may have reduced the current carrying capacity of this unit to 40-55 lynx. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943). There is significant risk for potential future wildfires to further affect the viability of lynx in this geographic unit. Burned habitats are expected to regenerate back into suitable lynx habitat, but this may take 35-40 years. The Kettle Range to the east of this unit was suspected to have supported a small (likely fewer than 20 individuals) resident population until about 30 years ago when over-trapping may have resulted in its extirpation (Koehler *et al.* 2008, p.1523). Potential impediments to lynx movement between the Kettle Range and the Cascades and British Columbia may make natural recolonization of the Kettle Range unlikely. Results of snowshoe hare research suggest that the hare population density in Washington exists at the low end of the range thought necessary to support lynx reproduction (>= 0.5 hares/ha). The OWNF and CNF, which administer more than 90 percent of lynx habitat in Washington, continue to manage lynx habitat on their forests in accordance with the LCAS. Additionally, the WADNR, which manages approximately 4 percent of lynx habitat in Washington, has developed and is implementing its 2006 Lynx Plan, which is also largely based on the LCAS.

Unit 5 - Greater Yellowstone Area (GYA): There are no reliable estimates of current or historic lynx numbers in this unit but, given its naturally-fragmented potential habitat, generally low hare densities, and the paucity of verified records, it appears unlikely this unit ever supported a large resident population. No lynx have been verified in this unit after 2010, but whether this indicates the extirpation of a small but previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit consists of federal lands (97.5 %) that are currently managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx. Wildfire extent has increased over the past several decades, predominantly in the northern half of the unit and likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Snow conditions currently appear to be adequate, with most of this geographic unit modeled to have a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12). Hare densities were very low in most of Yellowstone National Park but high in parts of the Bridger-Teton National Forest in the southern half of the unit. The role of past and recent immigration in maintaining the demographic and genetic health of lynx populations in this unit is unknown. This unit lacks direct connectivity to other lynx populations, and there is only anecdotal evidence that irruptions of lynx from Canada resulted historically in immigration into this unit. Some lynx released in Colorado dispersed northward into this unit and temporarily occupied home ranges in areas used previously by native resident lynx, but there is no evidence of reproduction among these lynx.

Unit 6 - Western Colorado: Lynx habitat in Colorado is distributed west of US Interstate-25. This unit is not directly connected to lynx populations in Canada. Compared to the time of listing and completion of the Southern Rockies Lynx Amendment, two bark beetle epidemics have altered

large areas of lynx habitat in Colorado. Similarly, large wildfires have reset successional conditions in many areas. Areas affected by beetles that contained multistoried stand conditions l kely continue to provide habitat to support snowshoe hares and lynx. Areas affected by beetles and fire require 20 plus years to recover to a point where the stands will again support snowshoe hares. The CPW completed their lynx reintroduction, and based on information generated during on-going studies, and reports received by CPW and the USFS, lynx continue to persist, at least in the San Juan Mountains. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell undocumented pers comm. April 4, 2016), and Rocky Mountain National Park (Shenk 2008, page 3). Habitat that supports snowshoe hares is patchily distr buted in this geographic unit, which limits their abundance. Because the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. The majority of lynx habitat in Colorado continues to be managed by the USFS, providing conservation through the Southern Rockies Lynx Amendment. However, regulatory mechanisms for the conservation of lynx are lacking on approximately 3,611 km^2 (1,394 mi^2) [14 percent] of some BLM, NPS, and other non-federal lynx habitat.

Table 3. Summary of current conditions in six geographic units within the DPS range.

	Unit 1 - Northern ME	Unit 2 - Northeastern MN	Unit 3 - Northwestern MT, Northeastern ID	Unit 4 - North-central WA	Unit 5 - Greater Yellowstone Area	Unit 6 - Western CO
Unit Size (km^2)	28,909	21,101	26,997	5,176	23,687	25,294
Percent of Unit in Conservation Ownership (i.e., Federal, State, Tribal, Other Conservation Org.)	<10	75 - 90	> 95	> 90	> 95	> 90
Connectivity to Lynx Populations/ Habitats in Canada	Directly connected to lynx habitats/ populations in s. Quebec and n. New Brunswick; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Ontario; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Alberta and s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown
Home Range Size (Adult Female, km^2)	26	17 - 21	43 - 115	37 - 91	50 (1 female, 3 years)	75 - 704
Productivity – Percent Females with Kittens	89% (high hares); 30% (low hares);	100%	83% (Purcells); 61% (Seeley Lake)	100% (2 females)	Few data	24%
Productivity - Litter Size	2.74 (high hares); 2.25 (low hares)	3.3	2.95 (Purcells); 2.24 (Seeley Lake)	2.25 (2 females)	3.0 (1 female, 2 years)	2.75
Average Annual Adult Survival Rate	0.80 (high hares); 0.71 (low hares)	0.75 - 1.00	0.85 (Purcells); 0.75 (Seeley Lake)	0.86	Few data	0.93 (in Core Release Area [CRA]), 0.82 (out of CRA)
Lambda (Annual Rate of Population Change)	1.16 (high hares, 6 yrs); 0.88 (low hares, 4 yrs)	No estimate	1.16 (Purcells, 4 yrs); 0.92 (Seeley Lake, 8 yrs)	No estimate	No estimate	No estimate

4.2 Current Conditions - Detailed Descriptions by Geographic Unit

4.2.1 Unit 1 - Northern Maine

The “Northern Maine unit” includes the core, occupied habitat in northern Maine, which is designated critical habitat. It also includes areas where lynx have recently occurred in western and eastern Maine and northern New Hampshire and Vermont. To be consistent with the Workshop Report, we refer to this collective region as the Northern Maine unit.

Unit Description: This unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) primarily in northern Maine, but also small areas of northern New Hampshire and Vermont. Climate in this region is characterized by warm summers and some of the coldest temperatures and highest snowfalls in the eastern U. S.; a function of latitude, elevation, and distance from the ocean. The average terrain rises in northern Maine to 1,000-1,500 feet with mountain peaks, particularly in western Maine, northern New Hampshire and Vermont from 3,000 to 5,000 feet. This region is far enough inland to be unaffected by marine influences. Annual precipitation is 41 inches (104 cm), with greatest precipitation in winter in the form of snow 228 cm to 280 cm (90 to 110-plus inches), with higher amounts at higher elevations. Snow duration is about four months (mid-November through mid-April).

Maine - Much of the lynx habitat in northern Maine occurs within the designated critical habitat boundary, which is approximately 28,909 square kilometers (11,162 square miles) all in northern Maine (79 FR pp. 54823-54828). Land ownership in the critical habitat unit boundary is about 92 percent private, 7 percent State (primarily Baxter State Park), 1 percent tr bal (Passamaquoddy Tribe, Penobscot Indian Nation), and contains no federal land. Private lands are almost entirely commercial forest lands. Lynx regularly occur outside of the designated critical habitat boundary in parts of eastern and western Maine and, recently, in northernmost New Hampshire and Vermont (see below).

New Hampshire - Habitat in northern New Hampshire is not within the designated critical habitat. Potential habitat is limited (Hoving 2001, p. 59), and the few habitat patches that support lynx in New Hampshire are much smaller than those in northern Maine (Litvaitis and Tash 2005, Fig. 2 and p. A–298; Robinson 2006, Fig. 3.3, p. 99). Hoving (68 FR 40086) estimated approximately 1,000 square kilometers (386 square miles) of potential habitat having a greater than 50 percent probability of being occupied by lynx. Litvaitis and Tash (2005, p. A–298) estimated that New Hampshire contains about 342 km2 (888 km2) of potential Canada lynx habitat. Historic distribution in New Hampshire included Coos and northern Carroll and Grafton counties (i.e. White Mountain National Forest; Siegler 1971, Silver 1974, Hoving *et al.* 2003). Habitats with the highest probability of occurrence are in Pittsburg in northern New Hampshire and the White Mountain National Forest in the central area of the state (Siren 2014, p. 34). The majority of the habitat in northern New Hampshire is located on the Connecticut Lakes Natural Area WMA which is owned and managed by NHFG. Surrounding habitat is owned and managed by the Connecticut Lakes Timber Company under a conservation easement held by the State of NH. Occurrence records from the past 10 years have been

centered on these two ownerships (Kilborn 2015, App. A pp. 42-43). Habitat on the Connecticut Lakes Natural Area has a conservation easement with 15,000 acres of the core lynx habitat also being part of an unmanaged area of the 25,000 acre property. As a result these core 15,000 acres will be allowed to mature to a climax forest type potentially allowing for good denning habitat but restricting the amount of snowshoe hare habitat in the foreseeable future. Current conditions are in a transition state, and portions of the 15,000 acres are supporting higher densities of snowshoe hare because of past forest management (Kilborn 2015, App. A pp. 42-43). Regional-scale modeling suggests that a high component of deciduous forest and insufficient snow conditions in New Hampshire are unlikely to support viable lynx populations over time (Hoving *et al.* 2005, pp. 739, 749).

Vermont - Habitat in northern Vermont is not within the designated critical habitat. Recent modeling to determine lynx habitat connectivity in the Northeast suggests that the Nulhegan River Basin contains Vermont's best lynx habitat (Farrell 2012). The 530 square kilometer (205 square mile) area is approximately 20 percent federal (Nulhegan National Wildlife Refuge), 17 percent State (Vermont Department of Natural Resources), and 63 percent private commercial timber lands (with easement). The future of lynx and their habitat is unlikely because of the patchy and limited amount of habitat, climate change (decreasing snow), trends toward hardwood management, and increasing human disturbance (Vermont Fish and Wildlife 2015, Appendix A5 p. 127).

The Northern Maine geographic unit is directly connected to lynx habitats and populations in southern Quebec and northern New Brunswick, Canada. Lynx in this unit represent the southern extent of a larger cross-border population, most of which occurs in the Gaspe region of southern Quebec and northern New Brunswick (Ray *et al.* 2002, pp. 17-20). Lynx in the northern Maine unit are geographically isolated by the St. Lawrence River from lynx populations in central Quebec (120 km north of Maine). Lynx populations in Maine and eastern Canada are geographically isolated from other lynx populations on the island of Newfoundland (900 km east of Maine), and on Cape Breton Island, Nova Scotia (650 km southeast of Maine) (Koen *et al.* 2015, entire). The closest lynx population in the DPS is located in northeastern Minnesota, about 1,700 km west of Maine.

Habitat Description: In the northern Maine unit, most lynx occurrence records are found within the broadly described ''Mixed Forest-Coniferous Forest-Tundra'' cover type (68 FR, p. 40086). This habitat type occurs along the northern Appalachian Mountain range from southeastern Quebec, western New Brunswick, and western Maine, south through northern New Hampshire. This habitat type becomes naturally fragmented and begins to diminish to the south and west, with a disjunct segment running north-south through Vermont, and a patch of habitat in the Adirondacks of northern New York (McKelvey *et al.* 2000b, pp. 248-250). This area is part of the Acadian Forest Region (Rowe 1972, p. 112-129) representing a transition between northern boreal spruce and balsam fir and southern temperate deciduous forests (Seymour and Hunter 1992, pp. 3-4). Northern Maine is characterized by low-relief, hilly terrain, but with some higher elevations up to 1,600 meters (Katahdin highlands, western Maine, White Mountains in central New Hampshire). Higher elevations support a predominantly coniferous forest (white, red, and

black spruce; balsam fir; eastern white pine) intermixed with northern hardwoods (red maple, aspen, white birch, sugar maple, beech, and yellow birch). Lowland areas include spruce-fir flats interspersed with peatlands (black spruce, tamarack).

Current lynx and hare habitat are associated with spruce-fir stands repeatedly harvested for forest products. Hares and lynx are associated with stands of regenerating sapling (15–35 years old) spruce-fir forest that provide dense cover (Robinson 2006, pp. 26–36; Vashon *et al.* 2012, p. 15). Lynx are more likely to occur in large (100 square kilometer, 40 square mile) landscapes having a high percentage (>27 percent) of regenerating forest, and less likely to occur in landscapes with very recent clearcut or partial harvest (Hoving *et al.* 2004, pp. 291–292, Simons-Legaard *et al.* 2013, entire). Regenerating stands used by lynx generally develop after forest disturbance (almost exclusively logging) and are characterized by dense horizontal structure and high stem density within a meter of the ground. These habitats support the highest snowshoe hare densities (Homyack 2003, p. 63; Fuller and Harrison 2005, pp. 716, 719; Vashon *et al.* 2005a, pp. 10–11). At the stand scale, lynx in northwestern Maine selected older (11- to 26-year-old), tall (15 to 24 feet (ft) (4.6 to 7.3 meters (m)) regenerating clearcut stands and older (11- to 21-year-old) partially harvested stands (Fuller *et al.* 2007, pp. 1980, 1983–1985). At the home range scale, lynx also select landscapes having some mature conifer forest (Simons-Legaard *et al.* 2013, pp. 572–573). Lynx may select partial harvested and mature conifer stands because of increased ease of travel and prey access along the extensive edges with high-quality (regenerating clear-cut) habitats (Simons-Legaard *et al.* 2013, p. 574).

Most of the high-quality hare and lynx habitat in northern Maine is the result of extensive landscape-scale clearcut timber harvesting in response to a spruce budworm outbreak in the 1970s–1980s (Simons 2009, pp. 64, 218). Some of these clearcuts were also treated with herbicides to promote conifer regeneration by suppressing deciduous tree species. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). Historically, the natural disturbance regime (fires, windthrow, insect outbreaks) resulted in smaller, more frequent disturbances and long intervals between larger disturbances.

Snowshoe hare populations in Maine do not seem to cycle at 10-year intervals, but have experienced a period of high (1995-2005) and low (2006 to present) populations (Scott 2009, pp. 1-44, D. Harrison, UMaine, unpub. data, Vashon *et al.* 2012, p. 14). Prior to 2006, several estimates of hare densities in the highest quality, regenerating conifer or mixed forest averaged 1.9 (Homyack *et al.* 2007, p. 8) to 2.1 hares/ha (Robinson 2006, p. 26,). After 2006, hare densities declined by about half in all stand types and have remained at these lower levels (Scott 2009, p. 109, D. Harrison, UMaine, unpub. data). Similar trends were observed in the Gaspe Region of Quebec (Assells *et al.* 2007, entire). In 1990, hare densities in dense, regenerating spruce-fir stands in New Hampshire were 0.5 hares/ha at low and high elevation (Brocke *et al.* 1990, p. 61). More recently, Siren *et al.* (2015) reported lower densities in New Hampshire (0.25 to 0.36 hares/ha) in both montane and lowland spruce-fir. Densities in high elevation (krumholtz, stunted spruce-fir) were only 0.19 to 0.28 hares/ha. Comparable hare

density data are not available for Vermont or New York. The average landscape hare density in home range-sized areas occupied by lynx in Maine was 0.74 hares/ha (Simons-Legaard *et al.* 2013, p. 567). Based on these observations, Simons-Legaard *et al.* (2013, p. 576) recommended maintaining landscape hare densities of at least 0.74 hares/ha (or 27 percent of 100 km2 areas in high-quality hare habitat) to conserve lynx.

Habitat Status: As elsewhere in the DPS, boreal spruce-fir forest habitats in the northern Maine unit are patchily distributed and intermixed with northern hardwoods, riparian areas, and peatlands. USFS forest inventory data indicate that four million acres of forestland are classified as spruce-fir in Aroostook, Penobscot, Piscataquis, and Somerset Counties in northern Maine (McWilliams *et al.* 2005, p. 122), although not all of this forest type is in areas occupied by lynx. In a 10 million acre area in northern Maine (approximately 50 percent of the designated critical habitat), Simons-Legaard (2016, p. 9-10) estimated that approximately 950,000 acres (9.5 percent) of spruce-fir was in a young, regenerating stand condition that provide high quality hare habitat. This habitat is similar to, and contiguous with, forested areas in Quebec and New Brunswick, Canada that support lynx (Hoving *et al.* 2005, pp. 740-741). The current range of lynx in the northern Maine unit is associated with areas of deep snowfall, extensive (100 km2 [40 mi2]) forested landscapes, and areas having a high proportion of regenerating conifer-dominated forest that had previously been treated with herbicides to suppress hardwoods (Homyack 2003, p. 2; Hoving *et al.* 2004, p. 287).

Lynx habitat in the northern Maine unit is associated with large-scale, intensive forest management (Harper *et al.* 1990, entire; Hoving *et al.* 2004, pp. 291-292; Simons 2009, p. 8; FR 74 8616–8701). Patches of boreal forest in New Hampshire, Vermont, and New York are more highly fragmented and smaller than in northern Maine. These more southerly forests also contain a higher proportion of northern hardwood. These forests are believed to lack the conifer component needed to produce sufficient snowshoe hare densities to consistently support viable populations of lynx (Hoving *et al.* 2005, p. 749, Carroll 2007, p. 1100).

During winter, lynx primarily selected tall (4.4–7.3 m [14.5–24 ft]) regenerating clearcuts and partially harvested stands that were 11–21 years post-harvest (Fuller *et al.* 2007, pp. 1984-1985). Lynx avoided mature stands (>40 years old) and short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partially harvested stands <10 years post-harvest (Fuller *et al.* 2007, pp. 1275-1278). Further research of year-round habitat use yielded similar results, with lynx preferentially using conifer-dominated sapling stands that were 3.4–7.3 m (11–24 ft) in height and supported high densities of snowshoe hares (Vashon *et al.* 2008b, pp. 1492-1495). Lynx tended to forage in areas with intermediate to high snowshoe hare densities (tall regenerating or older partial harvest stands), which afforded lynx with greater mobility and where snowshoe hares were more vulnerable to predation, rather than in the densest stands (short regenerating stands; Fuller and Harrison 2010, pp. 1276-1278).

Denning habitat included various types of coarse woody debris; blowdown, deadfalls, and root wads. In northern Maine, the majority of natal dens (12 of 26) occurred in conifer-dominated

sapling stands, and 6 dens were found in mature or mixed multi-story forest stands dominated by conifers (Organ *et al.* 2008, pp. 1515-1517).

In general, landscape scale and home range scale habitat selection by lynx on industrial forest lands reinforce the importance of dense regenerating conifer forest along with a component of mature conifers (Hoving *et al.* 2004, p. 286; Vashon *et al.* 2008a, pp. 1494-1495, Simons 2009, pp.64-110; Simons-Legaard *et al.* 2013, p. 568). Simons-Legaard *et al.* (2013, p. 573) found the probability of lynx occurrence was >50 percent when snowshoe hare landscape densities were >0.74 hares/ha (0.39/ac) and there was >10 percent mature conifer forest. In Maine, lynx selected softwood-dominated (spruce and fir) regenerating stands (Fuller *et al.* 2007, pp. 1983-1985; Vashon *et al.* 2008a, pp. 1492-1495) and adjacent older (11–21 years post-harvest) partially-harvested stands (Fuller *et al.* 2007, pp. 1983-1985). Lynx were more likely to occur in landscapes with abundant regenerating forest, and less likely to occur in landscapes dominated by recent clearcut or partially harvested stands (Hoving *et al.* 2004, pp.289-292). Regenerating stands used by lynx typically developed 15–30 years after harvest (Hoving *et al.* 2004, p. 291), and were characterized by high stem density and dense horizontal cover within 1 m (3 ft) of the ground (Robinson 2006 pp. 33-35, Scott 2009, pp. 81-93; Fuller and Harrison 2010, p. 1276-1278). These habitats supported high snowshoe hare densities (Homyack 2003, p. 53; Fuller and Harrison 2005, p. 716, Vashon *et al.* 2008a, p. 1492; Scott 2009, pp. 24, 32, 36-44). At a landscape scale, lynx habitat selection did not differ between sexes; however, at a home range scale, males tended to use more mature forest dominated by conifers than females, and both male and female lynx tended to avoid mature forests that had a high deciduous component (Vashon *et al.* 2008a, pp. 1492-1493).

Historically lynx habitat in the northern Maine unit was l kely uncommon. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). In the Northeast prior to European settlement, lynx habitat was created and maintained by frequent, small-scale forest gap dynamic events and infrequent, large-scale stand-replacing forest disturbances (Seymour *et al.* 2002, pp. 359-365; Lorimer and White 2003, pp. 54-58). Higher elevation boreal forests are often characterized by an even-aged wind-throw phenomenon known as fir-waves (Sprugel 1976, entire). Large, stand-replacing events (fire, wind and ice storms, insect outbreaks) are rare (interval of several hundred to several thousand years) and highly variable in size (Seymour *et al.* 2002, entire; Lorimer and White 2003, pp. 50, 54, 59). Spruce budworm, spruce beetle, beech bark disease, and sugar maple defoliators have been important influences affecting forest landscape patterns (McNab and Avers 1994, Chapter 14). The frequency and intensity of spruce budworm outbreaks, the most likely insect to affect lynx habitat, have been highly variable in Maine and eastern Canada in recent centuries (Blais 1983, entire). In this geographic area, wildfire is less significant as a natural agent of disturbance. The typical fire regime is infrequent surface fires in the dormant season in the hardwood forests, and slightly more frequent but long-interval fires in conifer forests (Kilgore and Heinselman 1990, entire; Seymour *et al.* 2002, pp. 359-365, Lorimer and White 2003, p. 59). For the past several decades, early successional forests and lynx habitat in northern Maine, New Brunswick, and

southern Quebec have been created almost exclusively by forest management (Lorimer and White 2003, pp. 42-43).

In contrast, current habitat is likely peaking and at historical highs. Favorable habitat conditions for snowshoe hare and lynx in Maine resulted from large-scale salvage cutting (clearcutting) following a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, p. 291). After salvage harvest of the affected trees, a portion of the area was sprayed with herbicide to reduce deciduous competition (Scott 2009, pp. 7, 14). The resulting vegetation was dominated by balsam fir and red or black spruce (Scott 2009, p. 60). This created favorable habitat conditions for snowshoe hares and lynx. Habitat conditions for hares and lynx in the unit improved from the late-1980s to present, benefitting from stand-replacing salvage harvests during the last budworm outbreak (Simons 2009, pp. 122-229; Simons-Legaard *et al.* 2016, entire). During this time period, the percentage of forestland with an average landscape hare density greater than 0.5 hares/ha increased 400 percent (Simons-Legaard *et al.* 2016, p. 7).

Lynx habitat will decline in the near future. In response the widespread clearcutting in the 1980s, in 1989 Maine passed the Forest Practices Act. This Act regulated clearcutting. Various forms of partial harvesting replaced clearcutting as the predominant form of forest management in northern Maine. Partially harvested stands (e.g., selection harvest, shelterwood harvest, overstory removal) have a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006, p. 29). On average, partially harvested stands support about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006, p. 26-27).

Maine's forest practices shifted dramatically after the Maine Forest Practices Act. Over 95 percent of cutting that occurs now in northern Maine is partial harvesting compared to 59 percent in 1988 (Scott 2009, p. 8; Simons 2009, pp.45-47, 69-71; Simons-Legaard *et al.* 2013). This new cutting regime supports lower landscape densities of snowshoe hares (Fuller 1999, Homyack 2003, Robinson 2006, Scott 2009).

Long-term, binding land management commitments are lacking in the northern Maine unit. Unlike federal lands, there is no requirement that private landowners comply with lynx management guidelines, and a federal nexus for review of projects is almost nonexistent. Furthermore, there continues to be high turnover in forest land ownership (Hagan *et al.* 2005, Nadeau-Drillen and Ippoliti 2006) and little funding to provide incentives or to work with private landowners. As of 2005, there were 23 landowners in northern Maine with land holdings in excess of 100,000 acres including the State, federal government (White Mountain National Forest south of lynx range), a conservation group (The Nature Conservancy), two tribes (Penobscot Indian Nation and Passamaquoddy Tribe with much land south of lynx range) and 18 private forest landowners (Nadeau-Drillen and Ippoliti 2006, p. 13).

There are short-term commitments to manage lynx habitat in the northern Maine unit. In 2003, Congress passed the Healthy Forest Restoration Act. Title V of this Act designates a Healthy Forest Reserve Program (HFRP) with objectives to: (1) promote the recovery of threatened and

endangered species, (2) improve biodiversity, and (3) enhance carbon sequestration. In 2006, Congress provided the first funding for the HFRP, and Maine, Arkansas, and Mississippi were chosen as pilot States to receive funding through their respective Natural Resources Conservation Service (NRCS) State offices. Based on a successful pilot program, in 2008, the HFRP was reauthorized as part of the Farm Bill, and in 2010, NRCS published a final rule in the Federal Register (75 FR 6539) amending regulations for the HFRP based on provisions amended by the bill.

In 2006 and 2007, the NRCS offered the HFRP to landowners in the proposed Canada lynx critical habitat unit in Maine to promote development of Canada lynx forest management plans. Since that time four private landowners, The Nature Conservancy, the Passamaquoddy Tribe, Merriweather LLC, and Katahdin Forestlands successfully enrolled in the program. Collectively, these land ownerships comprised 943.2 mi2 (2,443 km2), or 9.3 percent of the total designated critical habitat in northern Maine.

The NRCS required that lynx forest management plans must be based on the Service's ''Canada Lynx Habitat Management Guidelines for Maine'' (McCollough 2007, entire). These guidelines were developed from the best available science on lynx management for Maine. The guidelines required maintenance of landscapes having hare densities that support reproducing lynx populations. Notably, HFRP forest management plans provided a net conservation benefit for lynx, which was achieved by employing the lynx guidelines, identifying baseline habitat conditions, and meeting NRCS standards for forest plans. Plans met NRCS HFRP criteria and guidelines and complied with numerous environmental standards. Plans were reviewed and approved by the NRCS with assistance from the Service. The details of the plans are proprietary and will not be made public per NRCS policy.

Short-term commitments to lynx management will expire in 2016 and 2017. Unlike lynx forest plans on federal lands, HFRP plans lack long term commitments beyond an initial 10-year contract period. Plans were prepared for a forest rotation (70 years) and include a decade-by-decade assessment of the location and anticipated condition of lynx habitat on the ownership. However, landowners are only committed to a 10-year contract, and long-term commitments to lynx management are voluntary. Some landowners developed plans exclusively for lynx, and others combined lynx management (umbrella species for young forest) with American marten (umbrella species for mature forest) and other biodiversity objectives. All four plans have been completed and contracts with NRCS will expire in 2016 and 2017. Landowners have the option to convert HFRP contracts into Safe Harbor Agreements or other agreements to provide regulatory assurances, however, at this time this option has not been explored with landowners.

Many large private forest landowners in the northern Maine unit have commitments to endangered species management through forest certification programs. For example, The Nature Conservancy land enrolled in the HFRP is also enrolled in the Forest Stewardship Council (FSC) forest certification program, which requires safeguards for threatened and endangered species. Other landowners are certified under the Sustainable Forestry Initiative (SFI). Both certification programs require planning for threatened and endangered species.

However, certification programs are also voluntary and may not be long-term commitments. Given the frequent turnover in Maine forest lands, new landowners do not always renew certification or resume the certification programs initiated by the previous landowner.

Lynx Status: At the time of listing, lynx were known to be present in northern Maine but little was known about their distr bution, population size, and trend, snowshoe hare populations, and relationships to forest management. Since then, research from the Maine Department of Inland Fisheries and Wildlife (Vashon *et al.* 2008a, entire; 2008b, entire; and 2012 entire) and the University of Maine (Hoving *et al.* 2003, entire; Hoving *et al.* 2004, entire; Hoving *et al.* 2005, entire; Homyack *et al.* 2005, entire; Homyack *et al.* 2007, entire; Homyack *et al.* 2006, entire; Fuller *et al.* 2007, entire; Fuller *et al.* 2004, entire; Fuller and Harrison 2005, entire; Simons-Legaard *et al.* 2013, entire; Simons-Legaard *et al.* 2016, entire) have greatly increased our knowledge. Snow track surveys and confirmed occurrence records (Vashon *et al.* 2012, entire; Siren 2015, entire) document that lynx occur throughout northern Maine and in small, isolated pockets in western and eastern Maine, northern New Hampshire, and Vermont (Siren 2015, entire). Population size and trends are still uncertain.

The Northern Maine Unit currently supports a breeding population of lynx that encompasses most of northern Maine, with recent lynx occurrence and reproduction also documented in northernmost New Hampshire and Vermont. This geographic unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspe region of southern Quebec. Extensive areas of contiguous forestland in this region provide high connectivity between populations in Maine and Canada. Although potential lynx habitat in New Hampshire and Vermont is fragmented, there is near contiguous forest and connectivity for lynx movement between these areas and habitats in northern Maine (Farrell 2013 personal communication, FR 54821). Breeding lynx in New Hampshire and Vermont are not directly connected to Canadian populations, but they are connected to the larger population in northern Maine via habitat in western Maine.

Lynx in the Northern Maine Unit and adjacent populations in southern Quebec and northern New Brunswick are separated from lynx populations in the interior of Canada. The St. Lawrence River restricts lynx dispersal and demographically isolates this population from those in northern Quebec, Labrador, and Ontario. However, sufficient numbers of individuals cross the river on the ice each generation to prevent genetic drift of this population (Koen *et al.* 2015).

At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that a significant population currently exists and is supported by the extensive young, regenerating spruce-fir habitat created by clearcutting in the 1970s and 1980s. Habitat in northern Maine can support lynx densities in localized areas of high quality habitat that are substantially greater than elsewhere in the DPS (LCAS 2013, p. 23). In 2003 when hare populations were high, lynx density (juveniles and adults) in one of Maine's highest quality habitats was estimated to be 9.2-13.0 lynx/100km^2 (Vashon *et al.* 2008, Vashon *et al.* 2012, p. 15). At about the same time, the density of lynx in nearby Gaspe Peninsula, Quebec was estimated to be 10 lynx/100km^2 (Ray *et al.* 2002). These densities are intermediate to those

in Canada during the high (17.0-44.9/100km^2) and low periods (2.3 – 3.0/100km^2) of the lynx-hare cycle (Poole 1994, Slough and Mowat 1996, O'Donaghue *et al.* 1997). Simons (2009, p. 102) estimated there is potential for a population of about 236 to 355 adult lynx to occur on a 3.56 million acre study area (about half of the critical habitat area) in northern Maine, and Vashon *et al.* (2012, appendix IV) estimated there is potential for a population of 750 to 1,000 adult lynx in all of northern Maine in 2006. The actual number of lynx is unknown because there are no methods available to measure and produce true population estimates over such a large geographic area.

Lynx populations in New Hampshire and Vermont may consist of only a few animals, although breeding has occurred in both locations in recent years. Most historic lynx records from New Hampshire are from trapping records from the 1930s to the 1960s (Brocke *et al.* 1993, McKelvey *et al.* 2000). There were only two records in the 1990s. In 2003, the Service determined that, despite a lack of breeding records, a small resident population likely occurred historically in New Hampshire but no longer exists (68 FR 40087). Lynx were detected in northern New Hampshire in 2006 and have occurred there annually since (Siren 2014 pp. 53, 55). In 2011, 4 lynx kittens were observed in Pittsburg and were considered evidence of breeding in New Hampshire (Kilborn 2015 Appendix A p.44). There were only four historic records of lynx in Vermont prior to 2003. Since then, nine lynx sightings have been confirmed. Reproduction was first documented in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Vermont Fish and Wildlife 2015, Appendix A5 p. 126).

Lynx do not presently occur in the Adirondacks region of New York. A resident lynx population reportedly occurred in the northern region of New York, particularly in the Adirondack Mountains, but it was considered extirpated by 1900 (Brocke 1982, McKelvey *et al.* 2000b). However, there are 23 verified lynx occurrences since 1900, primarily from the Adirondack Mountains (McKelvey *et al.* 2000b). The most recent verified record was from 1973 (McKelvey *et al.* 2000b), which correlates to an extreme cyclic population high. Habitat and prey conditions were deemed suitable for a lynx reintroduction in 1989–1991 (Brocke 1982). The reintroduction was unsuccessful in establishing a population. In 2003 the Service concluded that a resident population may have existed in New York prior to 1900, however, records of lynx since 1900 are of dispersers (68 FR 40087).

Maine lynx had spatial and demographic parameters similar to some northern populations during the cyclic high in the snowshoe hare cycle (Brand *et al.* 1976, Parker *et al.* 1983, O'Donaghue *et al.* 1997). Maine lynx had among the smallest home ranges in the DPS (LCAS 2013, p. 24). During the period when snowshoe hare populations were highest, Maine lynx had among the highest reproductive rates (average litter size 2.74, 89 percent of adult females producing litters) in the DPS (Vashon *et al.* 2012, pp. 18-19). During the current period of low hare density, litter size was smaller, only 30 percent of females have litters, and mortality is greater. Home ranges are among the smallest in the DPS (54 + 5 km2 males; 26 + 4 km2 females, LCAS p. 24, Vashon *et al.* 2008a). Home range sizes were similar during periods of high and low hare density (Mallett 2014). Lynx populations likely increased during the period of

high hare density (lambda [λ] = 1.16) and declined during periods of low hare density (λ = 0.88) (USFWS, Vortex10, deterministic population simulation 2016; demographic data from Vashon *et al.* 2012).

In summary, Maine lynx and hare habitats are at historical highs. In the Northeast prior to European settlement, lynx habitat was created and maintained by small-scale, frequent forest gap dynamic events and large-scale, infrequent (stand-replacing) forest disturbances (Seymour *et al.* 2002, Lorimer and White 2003). Historically, lynx distribution was patchy, and lynx populations were likely low and dependent on immigration from Canada. Current habitat is the result of widespread clearcutting and herbiciding to salvage spruce and fir damaged by a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Maine lynx at multiple scales select extensive areas of regenerating, dense (7,000 – 14,000 stems/ha) spruce-fir stands 15 to 35 years after clearcut or other even-aged harvest (Hoving *et al.* 2005, Fuller *et al.* 2007, Vashon *et al.* 2008, Simons-Legaard *et al.* 2013). Lynx habitat is expected to remain stable for the next few years then decline (Simons-Legaard *et al.* 2016).

Factors Affecting Current Conditions: *Climate Change* - Climate change is affecting temperature, snow, and precipitation patterns in the Northeast at rates faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46º C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Climate change has, and will continue to affect lynx by reducing snow and boreal forest (see section 5.1.1).

Snow Duration, Depth, and Quality - As noted in chapter 2, lynx occur where there is regularly at least four months (120 days) of continuous snow coverage (Gonzales *et al.* 2007). Snow cover days in northern New England (1965-2005) ranged from 60-121 days and declined an average of 3.6 days/decade from 1965-2005 (Burakowski *et al.* 2008). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Thus, average conditions in Maine are currently at or below the snow persistence thresholds believed to be needed to support lynx (Gonzales *et al.* 2007). Similarly, the largest snow depth decreases in Canada in the last six decades have been observed in the lower St. Lawrence Valley, immediately north of Maine (Brown and Braaten 1998, pp. 48-52).

Lynx in the Northeast and eastern Canada occur where there is regularly total snowfall of at least 270 cm/yr (106 in/yr; Hoving *et al.* 2005), which defines the distribution of lynx and bobcat in this region (Hoving *et al.* 2005, Carroll 2007, Peers *et al.* 2013). Average annual snow depth at 5 weather stations within the range of the lynx in northern Maine (1981-2010) was below this threshold, 228-263 cm (NOAA 2011, http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html, last accessed 31 March, 2016). In the last 50 years, 18 of 23 snow sampling sites in and near Maine experienced reduce depth of snowpack (Hodgkins and Dudley 2006). Snow depth in New England (1965-2005) declined

an average of 4.6 cm/decade (Burakowski *et al.* 2008). Thus, average snow conditions in Maine are currently at or below this snow depth threshold, and further declines in annual snow depth would be expected to give bobcats a competitive advantage over lynx (Hoving *et al.* 2005,)

As noted in chapter 2, lynx and snowshoe hare require deep, fluffy snow that provides lynx with a competitive advantage over bobcats and gives hares the ability to reach winter browse. Snow quality ("fluffiness") has deteriorated in the Northeast. Unlike other units, annual precipitation in Maine is increasing because of climate change, but primarily as rain (A. Siren *in* Lynx SSA Team 2016, p. 15; Fernandez *et al.* 2016), and especially rain on snow events in winter in northern Maine (Huntington and Hodgkins 2004, Deser *et al.* 2013, Fernandez *et al.* 2015). Snow density and compaction and crust conditions (caused by wet, heavy snow or rain on snow events in winter) have increased in northern New England (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006) and southern Canada (Karl *et al.* 1993).

Vegetation Management - The effects of forest management on foraging and denning habitat for lynx in northern Maine are discussed in the Habitat Description and Habitat Status sections above.

Wildland Fire Management - Although fire is frequent in many boreal forest regions, it is not a stressor for lynx in northern Maine. Annual precipitation is comparatively greater in this unit than others, and conditions for fire are infrequent. The fire regime in this unit is infrequent (50- to 200-year interval) and generally small (several acres) surface fires in the dormant season. Large (up to 80,000 acres) stand-replacing fires are rare and occur at a less frequent interval (800- to 9000-years) (Seymour *et al.* 2002 p. 360). In contrast, spruce budworm outbreaks cause stand-replacement over large areas every 100–250 years (Cogbill, 1985).

Habitat Fragmentation - Habitat fragmentation (smaller and more isolated patches of high quality hare habitat) caused by current forest practices in northern Maine is discussed in the Habitat Description and Habitat Status sections above.

Other Factors: *Trapping* - This unit is directly connected to lynx habitats and populations in southern Quebec, where trapping of lynx is legal. Several lynx that were captured and radio-tagged in northern Maine were subsequently trapped in southern Quebec (Vashon *et al.* 2012).The lynx trapping season was closed in the Northern Maine Unit (including New Hampshire and Vermont) for decades prior to lynx being listed as a threatened species. Carroll (2007) modeled lynx populations in this unit and demonstrated that increased trapping pressure in Quebec could have a negative effect on protected lynx populations in Maine and New Brunswick. About 400 lynx are trapped and killed annually in Quebec south of the St. Lawrence River (http://mffp.gouv.qc.ca/english/wildlife/statistics/index.jsp last accessed May 19, 2016). In 2014, the Maine Department of Inland Fisheries and Wildlife (MDIFW) obtained an incidental take permit from FWS for lynx trapped incidental to other furbearer trapping in Maine. From 2000 to 2015, 108 lynx have been reported captured in traps set for other species and 7 of those were killed (Vashon *et al.* 2012, MDIFW 2014, p. 75). No lynx have been reported

incidentally trapped in New Hampshire or Vermont since 2000. In Maine, after two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions (e.g., requiring killer-type traps be placed in exclusion boxes, eliminating the use of drag sets for foothold traps) to further reduce mortality and injury of incidentally-trapped lynx.

Trapping of Canada lynx can be additive to other sources of mortality and have population-level effects (Brand and Keith 1979, Koehler and Aubrey 1994). Thus, harvest regulations for lynx are modified when hare and lynx populations are low (Bailey *et al.* 1986). Trapping mortality is not l kely to have a great effect on lynx populations in northern Maine and adjacent Canada when lynx are at historically high numbers, but trapping could have a synergistic and negative effect if hare and lynx populations decline, habitat declines, or climate change further stresses lynx (Slough and Mowatt 1996, Carroll 2007).

Wind Power Development - In response to climate change, wind development has escalated in northern and western Maine posing a potential threat to high and low elevation spruce-fir habitats (Whitman *et al.* 2013). Climate conditions are at or falling below threshold values needed to support lynx in Maine (see section above). Maine has experienced a rapid increase in wind energy development (http://www.eia.gov/electricity/data/browser, last accessed August 2, 2016), and there is increased interest in placing developments on private lands in unpopulated areas throughout northern Maine, New Hampshire, and Vermont. Wind energy is an increasingly appealing source of income for investment companies and other landowners who own forestland in the northern Maine unit. As of 2016, at least 11 wind projects have been proposed in northern Maine and 5 projects are in operation; 2 have been proposed in northern New Hampshire and 2 are in operation; and 3 have been proposed for northeast Vermont and 2 are in operation or under construction. Maine's two largest wind projects (combined over 200 turbines covering 360 mi2) are proposed entirely within Maine's lynx critical habitat. The effects of wind energy projects on lynx, hares and their habitat are undocumented. Potential direct effects include disturbance or displacement of resident lynx and loss and fragmentation of habitat from turbines, roads, and transmission lines. Increasing power infrastructure associated with these projects could greatly change development potential and patterns in northern Maine by bringing electricity into the interior of Maine's vast, undeveloped forest region. Extensive road construction further fragments habitat and increases access for recreation, including trapping.

Changing Land Ownership and Development - Until recently, the northern Maine unit was largely undeveloped, industrial forestland, but land ownership patterns have changed significantly in the last 15 years (Nadeau-Drillen and Ippoliti 2006). Some investment-oriented landowners are seeking diversified financial returns on their investment, including developing residential housing, second homes, and resorts. Two large residential and resort areas have been proposed on forestlands within the Maine critical habitat area. Both development projects would result in the development of several thousand acres of potential lynx habitat, but would be mitigated by substantial (100,000s of acres) conservation easements on surrounding forestland. Another private landowner proposes donation of a 87,000 acres within the lynx critical habitat for a federally-designated national park or monument. This area currently has a legacy of young-regenerating spruce-fir habitat from previous industrial forest landowners, but a park or

monument designation would forego future forest management. Another conservation landowner, The Nature Conservancy, continues forest management on about half of its 185,000 acre ownership, including managing part of the area for Canada lynx.

Construction or expansion of developed areas such as residential areas and resorts, as well as smaller recreational sites like nordic ski huts or campgrounds, may directly remove forest cover. Such removal in lynx habitat could decrease prey availability, affect lynx movement within home ranges, or result in a more fragmented landscape. Development further fragments habitat from road and highway construction (along with associated increases in traffic volumes and/or speeds).

Northern Maine Unit Summary - In summary, lynx are currently widespread throughout northern Maine and in small patches of habitat in northern New Hampshire and Vermont. Habitat exists to support a potential population of 500 to 1000 lynx, although the actual population size is unknown. Habitat created by extensive clearcutting 30 to 40 years ago is peaking and will decline by 50 percent in the next 15 to 20 years (Simons-Legaard 2016, p. X; also see section 5.1.1, below). Furthermore, hare populations declined by 50 percent starting in about 2006 and have remained at lower levels. Future hare fluctuations or cycles are uncertain. Active management of forest lands can produce lynx habitat, but landowners do not have long-term commitments for doing so. Land ownership has dramatically changed in northern Maine, and the majority of lands are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with lynx habitat. Greatest stressors are habitat loss (shifts in forest management from clearcutting to partial harvesting resulting in lower landscape hare densities), lack of forest planning for lynx, and climate change (diminishing snow depth, quality and duration; competition from bobcats and fishers; loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing ice conditions on the St. Lawrence River).

4.2.2 Unit 2 - Northeastern Minnesota

Unit Description: This unit encompasses approximately 21,100 square kilometers (8,147 square miles) in northeastern Minnesota. It includes the area designated as critical habitat in 2014 (79 FR 54782) and an additional relatively small area of tribal land in northern Minnesota that was excluded from critical habitat. Land ownership in this unit is about 47 percent federal (primarily USFS, with some NPS and BLM land); 36 percent State; 16 percent private; and 1 percent Tr bal (Grand Portage Reservation) (see Table 1). This unit includes most of Superior National Forest (SNF; including the Boundary Waters Canoe Area Wilderness [BWCAW]) and Voyageurs National Park. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit l kely represent the southern extent of a larger cross-border population, most of which occurs in Ontario (ON). Relative to other DPS lynx populations, this unit is about 1,480 km (920 mi) east of the Northwest Montana/Northeast Idaho Unit and about 1,610 km (1,000 mi) west of the Northeastern Maine geographic unit.

Habitat Description: In Minnesota, most lynx occurrences are associated with the Mixed Deciduous/Conifer Forest (McKelvey *et al.* 2000b, pp. 246, 248) within the Laurentian Mixed Forest Province (McNab *et al.* 2005, p. 5). Most of this province is characterized by low-relief hilly landscapes with glacial features and an elevation from sea level to 2,400 feet (730 meters), including many lakes and rivers. This unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps and black spruce or tamarack bogs. Coniferous and mixed-coniferous/deciduous vegetation types are dominated by balsam fir; black and white spruce; northern white cedar; Jack, white and red pine; hemlock; and tamarack; mixed with aspen and paper birch (Burdett 2008, p.5; Moen *et al.* 2009, pp.1-2; McCann and Moen 2011, p. 510). Burdett (2008, p. 57) reported that lynx in Minnesota selected regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites were associated with regenerating and mixed forest. McCann and Moen (2011, p. 513) found snowshoe hare densities were highest in regenerating forests. Females selected large woody debris and dense horizontal cover in lowland conifer cover for denning in northern Minnesota (Moen *et al.* 2008, p. 1510), but other cover types were used if recent blowdowns were present (Moen and Burdett 2009, p. 5).

Hare density in parts of northeastern Minnesota appears to be sufficient to support a viable lynx population (Moen *et al.* 2008, p. 1512), ranging between 0.3–2.0 hares/ha (0.12–0.8 hares/ac; McCann 2006, p. 17). Hare populations in northeastern Minnesota appear to be patchily distributed, but are most consistently abundant in 10-30 year old regenerating forests (McCann 2006, p.45). Pellet count data prior to the 1990s show evidence of density fluctuations of snowshoe hare populations occupying Minnesota (Fuller and Heisey 1986, pp. 262-263), but these fluctuations were not observed during the 1990s (Hodges 2000b, p. 172). Snowshoe hare habitat in Minnesota primarily consists of conifer forests with dense low-growing understories, lowland shrub and conifer bogs. Conifer bogs or lowland conifer forests may be especially important during low points in hare cycles by acting as refugia for hares. Early regenerating or pole-sized stands are not used as much as in other portions of their range, although older regeneration stands were used frequently in Minnesota (McCann 2006, p. 45). Sapling-sized aspen adjacent to conifer cover may also provide functional snowshoe hare habitat. McCann and Moen (2011, pp. 512-513) mapped the distribution of predicted snowshoe hare habitat across northeastern Minnesota. In northeastern Minnesota, edge habitats and regenerating conifer stands appeared to be important for snowshoe hare populations (Burdett 2008, p. 58; McCann 2006, p. 45), as were dense habitats containing balsam fir, white spruce, and cedar (Fuller and Heisey 1986, p. 263). Recent research indicates that the red squirrel is not an important prey species for lynx in northeastern Minnesota (Burdett 2008, p. 62; Hanson & Moen 2008, p. 9).

Average annual snowfall in this unit ranges from about 180 cm (71 in) in the northwestern part of the unit near International Falls, Minnesota to 219 cm (86 in) in Duluth, Minnesota, on the southern end of the unit, to 228 cm (90 in) in Tofte, Minnesota, near the lake shore on the far eastern-central part of the unit, to 228 cm (90 in) in Isabella, Minnesota, near the center of the unit, to the 107 cm (42 in) in Grand Portage, Minnesota, at the northeastern tip of the unit. More

snow is produced along Lake Superior, because of the lake effect (https://snowfall.weatherdb.com/d/a/Minnesota; accessed 4/25/2016).

Habitat Status: Friedman and Reich (2005, p. 732) conducted a spatially explicit forest composition change analysis on a 3.2 million hectare study area in northeastern Minnesota, which was based on General Land Office Survey records from the late 1800s and the 1990 USFS Inventory and Analysis Survey. The study documents altered forest tree species abundance, proportional basal area, and spatial distribution patterns. The proportionally most abundant species in northeastern Minnesota shifted from the presettlement period (spruce, 21 percent; larch, 15 percent; and paper birch, 15 percent) to aspen (30 percent), spruce (16 percent), and balsam fir (16 percent) in 1990. White pine declined from 20 percent to 5 percent basal area dominance, birch from 16 percent to 13 percent, spruce from 14 percent to 9 percent, and larch from 12 percent to 2 percent, while aspen increased from 8 percent to 35 percent basal area dominance.

In 2015, the SNF estimated that there were approximately 759,700 acres (60 percent of lynx habitat on the SNF) of suitable snowshoe hare habitat on the SNF and that only 23,800 acres of habitat on the SNF was in a condition unsuitable to lynx (USDA 2016, unpublished data).

The SNF continues to manage in accordance with its 2004 Forest Land and Resource Management Plan (USDA 2004, entire). The Forest Plan emphasizes providing sustainable amounts of timber, maintaining or enhancing biodiversity, contributing to economic and social needs of the community, and managing in an environmentally sound manner to produce goods and services that provide for long-term public benefits (USDA 2004, entire). The Forest Plan includes many objectives, standards, and guidelines for the protection of lynx and enhancement of lynx habitat that are based on recommendations in the 2000 LCAS. LAUs were delineated on the SNF in 2000 as the smallest landscape scale on which to analyze effects to lynx. The boundaries have remained in place since that time to allow for long term analysis of project effects. However, the SNF Plan proposed several changes of current LAU boundaries, such as adding LAUs to the Virginia Management Unit of the Laurentian Ranger District; designating the BWCAW a lynx refugium.

This unit is directly connected to lynx habitats and populations in southern Ontario, where trapping of lynx is legal. Habitat connectivity within and between portions of northeastern Minnesota and Canada appears functional based on radio-telemetry data that have documented lynx movements between Minnesota and Ontario (Burdett *et al.* 2007, p. 458; Moen 2009, pp. 4-6; Moen *et al.* 2010b, p. 5).

Lynx Status: At the time of listing, the Minnesota population was not believed to contribute significantly to the DPS. However, we now know that a reproducing resident population exists in northeastern Minnesota. Moen (*in* Lynx SSA Team 2016) recently estimated the potential for a population of about 50 to 200 lynx to occur in northeastern Minnesota. In 2008, Moen *et al.* (2008b), estimated the number of lynx that might be resident in northeastern Minnesota at a given time as between 190 and 250 individuals, assuming that about 25 percent of northeast

Minnesota is suitable lynx habitat, coupled with assumptions about residence time and detectability. The actual number of lynx is unknown because methods have not been implemented to measure and produce precise population estimates over such a large geographic area. We have no estimates of lynx densities in Minnesota.

Home range sizes in Minnesota were reported as 194 km^2 (75 mi^2) males and 87 km^2 (34 mi^2) females (Mech 1980, p.263). Later radio-collar data show that males had much larger home ranges 267 km^2 (103 mi^2) than females 21 km^2 (8 mi^2); and that females with kittens had the smallest home range (Burdett *et al.* 2007, pp. 460-461). A study of radio-collared lynx in Minnesota documented approximately 40 percent of male and female lynx making long distance movements outside of their home range between Ontario, Canada and Minnesota (Moen *et al.* 2010b, p. 17). Of those lynx that made long-distance movements, females tended to move 62-124 miles (100-200 km) and did not return to their original home range, while males moved 31-49 miles (50-80km) back and forth between Ontario and Minnesota (Moen *et al.* 2010b, p. 17). While topographic features may influence lynx movements in mountainous western states, lynx in Minnesota tended to move nearly straight paths (Moen *et al.* 2010b, p. 13).

The SNF and others have identified 268 unique individual lynx (48 percent Female, 51 percent Male) from DNA samples taken since 2000 (Catton *et al.* 2015, p. 1). Of the 1,306 DNA samples, 1,039 were identified as lynx, however 42 samples were identified as F1 lynx-bobcat hybrids (Catton *et al.* 2015, p. 1). Of those 42 hybrids, 13 unique individual lynx-bobcat genotypes (5 Female, 8 Male) were also identified (Catton *et al.* 2015, p. 1). The DNA analyses also showed persistence of individual lynx in Minnesota of 2 years (N = 27 lynx), 3 years (N = 11), 4 years (N = 5), 5 years (N = 6), and 1 female lynx tracked for over 5 years, who produced 7 kittens in Minnesota (Catton *et al.* 2015, pp. 3-5).

Since 2000 the U.S. Fish and Wildlife Service has been tracking incidental take of lynx; 29 lynx mortalities have been reported from trapping, shooting, vehicle collisions, and railroad mortalities in Minnesota. Thus far, of 26 lynx documented to have been incidentally trapped in Minnesota, 11 died and 15 were released alive (U.S. Fish and Wildlife Service, unpublished database 2016). The documented incidents largely occurred during legal trapping that targeted bobcat, coyote, fox, and marten, and involved a variety of traps including foot-holds, body gripping traps, and snares (U.S. Fish and Wildlife Service, unpublished database 2016). In addition, seven lynx mortalities as a result of being incidentally shot have been documented in Minnesota and 16 died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Lynx emigrating from Minnesota to Ontario exposes them to trapping and shooting that is allowed in accordance with regulated harvest in Canada. At least a third of the animals radio-collared in Minnesota spent time in Ontario; 4 radio-collared lynx were legally harvested (trapped) in Canada between 2003 and 2010, and two died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Furthermore, nine lynx mortalities due to vehicle collisions have been documented in Minnesota since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). Minnesota has relatively high forest road and highway densities that intersect lynx habitat and several radio-collared lynx in Minnesota inhabited home ranges that were bisected by highways. In addition to road mortalities, two railroad mortalities

have been documented since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). It is probable that there are additional incidental catches that are not reported each year (Moen 2009).

Factors Affecting Current Conditions: Identified factors affecting to the current conditions of lynx in Minnesota include reduction in habitat quality or quantity, habitat fragmentation, climate change, increased access for competing carnivores, and human-caused mortality. The SNF is currently implementing the 2004 SNF Plan (USDA 2004, entire), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the SNF has a long-term commitment for doing so; however, private landowners do not. Under the Sustainable Forest Resource Act of 1995, the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx. The implementation of the MFRC guidelines is monitored annually (e.g., MDNR 2015, entire). Thus, the several risk factors are being minimized and managed to promote the conservation of lynx within the SNF, however implementation of the guidelines on privately owned lands is voluntary.

Activities that change forest structure can affect habitat quantity and quality for lynx and snowshoe hares, their primary prey source. Thinning and other timber management practices that reduce stem density and downed material and promote more open, mature stands can reduce habitat quality and quantity. Throughout the Superior National Forest and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Mineral exploration and development is increasing in portions of Minnesota, particularly for hard rock (non-ferrous) minerals. Some of the area of interest for minerals overlaps with lynx habitat in northeastern Minnesota. Mineral exploration may result in short-term displacement of lynx. Mining activities and associated development may result in an irreversible loss of habitat or increased mortality risk. The specific effects to lynx and their habitat will depend on the scale and type of each project.

Roads are a factor in human-caused lynx mortality where they provide access to areas where lynx occur, increasing the risk of negative interactions between people and lynx. Throughout the SNF outside the BWCAW, high and low standard roads bisect many areas that provide potential or suitable lynx habitat. Additionally, bobcat harvest in northeastern Minnesota has been increasing over the last decade (Erb 2012, unpaginated). Where lynx and bobcat overlap, there is potential for accidental shooting of lynx, or for bobcat hunting with dogs to harass or harm lynx.

Snow compacts under natural conditions; however, snow compacted by human activity may increase access by coyotes and bobcats to prey in deep snow conditions where historically they were excluded or rare. Winter road use, snowmobiling, cross country skiing, and dog sledding

all have the effect of compacting snow. Outside the BWCAW, snowmobile activity is extensive and increasing significantly. The SNF has 705 miles of snowmobile trails and 1,562 miles on all ownerships within the proclamation boundary (USDA 2011). Advances in snowmobile capabilities have raised concerns about intrusion and new snow compaction in areas previously not vulnerable to high levels of snowmobile use. In addition, new road construction in lynx habitat has made more areas accessible during winter. These routes could be used by snowmobiles even if new roads are designated as closed to motorized public travel during other seasons. The SNF has 1,927 miles of low standard roads (OML 1 and 2) and 158 miles of temporary roads (USDA 2011). All of these factors have potential to reduce the deep and fluffy winter snow conditions and to reduce the competitive advantage of lynx in areas that typically receive deep snows.

As described in Chapter 2, above, lynx are adapted for surviving in areas that have cold winters with deep, fluffy snow, where they outcompete potential competitors such as bobcats, coyotes, and wolves (Buskirk *et al.* 2000a, pp. 90-91; McCord & Cardoza. 1982, pp. 748-749; Ruediger *et al.* 2000). The geographical distr bution of bobcat harvest in Minnesota has remained relatively static with a lack of harvest in the Arrowhead region of Minnesota (the region encompassed by Cook, Lake and St. Louis counties in northeastern Minnesota) (Erb 2009 cited in Kapfer 2012, p. 16, Erb 2012, pp. 7-9) and annual snow track and scent stations surveys support the conclusion that bobcats are as rare in the Arrowhead as harvest indicates (MN DNR unpublished data cited in Kapfer 2012, p. 23). However, this may change with decreased snow conditions predicted to occur due to climate change (Kapfer 2012, p. 25). Bobcat and coyote populations already appear to be increasing in Minnesota (Erb 2014, p. 40). If snow depth and duration decrease in the Arrowhead, deer mortality may be reduced which may potentially increase bobcat densities and bobcat expansion into northeast Minnesota (Kapfer 2012, p. 25). According to annual track surveys, wolf populations in Minnesota are currently stable (Erb 2014, p. 40), however, similar to bobcat, wolf populations may increase with changing snow conditions and prey availability as influenced by climate change.

Furthermore, in Northeastern Minnesota, several lynx-bobcat hybrids have been documented (Catton *et al.* 2015, p. 1), however, most bobcat records occur south and west of the core part of the lynx range in Minnesota (see figure 1.1 *in* Kapfer 2012, p. 51). Bobcat populations are increasing in Minnesota (Erb 2014, p. 40) and more bobcat-lynx hybridization may occur as a result of climate change (Koen *et al.* 2014, p. 113).

4.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Unit Description: This geographic unit includes the parts of northwestern Montana and northeastern Idaho the Service designated as critical habitat (Unit 3) for lynx in 2014 and some Tr bal and State lands that were excluded from that designation (79 FR 54825). It encompasses approximately 27,000 km^2 (10,424 mi^2) in portions of Boundary County in Idaho and Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton Counties in Montana, with ownership that is 84 percent federal (USFS,NPS, and BLM); 8 percent private; 4 percent State; and 4 percent Tribal. Most federal lands in this unit (82 percent) are on national

forests managed by the USFS; with NPS (16 percent) and BLM (almost 2 percent) contr buting most of the remainder. This unit includes most of Glacier National Park and parts of the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests, the BLM's Garnet Resource Area, and the Confederated Salish and Kootenai Tribes Flathead Reservation. It also includes (from northwest to southeast) all or parts of the Purcell, Cabinet, Salish, Whitefish, Lewis, Flathead, Swan, and Garnet mountain ranges. Several areas adjacent to this unit are known or thought to support a small number of resident lynx, at least intermittently, including the southern Selkirk Mountains of northern Idaho and northeastern Washington and the western Cabinet Mountains of northern Idaho (B. Holt 2016, pers. comm.; USFS 2015, pp. 9-10), and a small area of the Helena National Forest just south of MacDonald Pass, between Helena and Missoula (Gehman *et al.* 2011, p. 21). This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit may represent the southern extent of a larger cross-border population that also occurs in southwestern A berta and southeastern British Columbia (B.C.). Relative to other DPS lynx populations, this unit is about 200 km (125 mi) east of the north-central Washington unit, about 145 km (90 mi) northwest of the GYA, and about 1,480 km (920 mi) west of the Northeastern Minnesota geographic unit.

Habitat Description: In the Northern Rocky Mountains, most lynx occurrences are associated with the Rocky Mountain Conifer Forest or Western Spruce-Fir Forest vegetative classes (Kuchler 1964, p. 4; McKelvey *et al.* 2000a, p. 246) at elevations ranging from 1,250 m (4,100 ft) to 2,500 m (8,200 ft) (Aubry *et al.* 2000, pp. 378–380; McKelvey *et al.* 2000a, pp. 243–245). The dominant vegetation that constitutes lynx habitat in these areas is subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanii*) and lodgepole pine (*Pinus contorta*) (Aubry *et al.* 2000, p. 379; Ruediger *et al.* 2000, pp. 4-8 - 4-10). Within these vegetation types, lynx appear to prefer areas of moderate to gentle topographic relief (Koehler and Aubry 1994, p. 86; Apps 2000, p. 352; Squires *et al.* 2013, pp. 187, 191). Lynx use large landscapes that include a temporally- and spatially-shifting mosaic of forest age classes, where natural or anthropogenic disturbances may reset forest succession (ILBT 2013, p. 28). Early successional stages that often provide dense horizontal cover at ground/snow level and support high hare densities (Griffin 2004, pp. 53-54, 70; Squires *et al.* 2010, pp. 1654-1656) may be created and maintained by natural disturbance processes including wildfire, insect infestations, tree diseases, and wind events (ILBT 2013, p. 28). Timber harvest, other silvicultural treatments, wildfire management, or other vegetation management, which may be beneficial, benign, or adverse to lynx and hare habitats depending on prescription, extent, and implementation, can also influence the amount and distr bution of early successional stands (Agee 2000, p. 39; ILBT 2013, pp. 28, 71-76). Likewise, natural disturbance regimes and forest management can also influence the amount and distr bution of mature multistoried spruce-fir stands, which can include dense horizontal structure, support high hare densities (Griffin 2004, pp. 53-54, 70; Squires and Ruggiero 2007, pp. 313-314; Berg *et al.* 2012, pp. 1483-1485), and provide preferred winter foraging habitat for lynx (Squires *et al.* 2010, pp. 1653-1657).

In northwestern Montana, lynx generally occur in mid-elevation (1,260 – 2,355 m [4,130 – 7,730 ft]) moist subalpine mixed-conifer forests dominated by Englemann spruce and subalpine fir and including Douglas fir (*Pseudotsuga menziesii*), western larch (Larix occidentalis), and lodgepole

pine (Squires *et al.* 2010, pp. 1653-1654). Lynx home ranges occur in areas with low surface roughness (i.e., low topographic relief; gently-sloping to moderately-steep terrain), high canopy cover indices, and little open grassland (Squires *et al.* 2013, p. 191). These lynx habitats occur below the alpine zone and above drier, more open forest types (e.g., ponderosa pine [*Pinus ponderosa*] and dry Douglas-fir/western larch/lodgepole pine) that do not provide lynx habitat (Agee 2000, p. 42; Berg 2009, p. 20; Squires *et al.* 2010, p. 1655). As elsewhere in the western portion of the DPS, this elevational pattern contr butes, along with the transition from boreal to more temperate forests, to a naturally patchier, more fragmented distribution of lynx habitat than in the continuous boreal forest landscape in the core of the lynx's North American range in northern Canada and interior Alaska (65 FR 16052-53; 68 FR 40089; Squires *et al.* 2006[a], pp. 46-47; ILBT 2013, pp. 76-77; Squires *et al.* 2013, p. 191; 78 FR 59438). Squires *et al.* (2013, pp. 187-189) used telemetry data to model the distribution of probable lynx habitat in a 36,096-km^2 (13,937-mi^2) study area that completely overlaps this geographic unit. Their results indicate that much of the area has a low to moderate probability of selection by lynx, and that the areas with higher selection probabilities are relatively small and patchily- but widely- distributed throughout the unit and are separated by intervening areas of low probability of lynx use (Squires *et al.* 2013; see Figure 1(a), p. 189). This patchy distribution of high-quality habitats interspersed with areas of low-quality or non-habitat results in naturally lower densities of both snowshoe hares and lynx than those in the continuous boreal forests of northern Canada and Alaska (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373–375, 382, 394).

In winter in this unit, lynx preferentially use mature multistoried forest stands, predominantly spruce-fir, with dense horizontal cover, and they avoid clearcuts and large forest openings (Squires *et al.* 2010, pp. 1648, 1653–1656). In summer, lynx also select young stands with dense spruce-fir saplings, do not appear to avoid openings as in winter, and use slightly higher elevations (Ibid.). Both mature multistoried and young regenerating stands provide dense horizontal structure at ground/snow level, which supports higher snowshoe hare densities than more open young or mature forests. In the central (Seeley Lake study area) part of this unit, during an apparent regional hare decline in 1999-2001, summer hare densities were highest (up to 1.4 hares/ha in one study area) in dense young stands and winter densities were highest (up to 1.8 hares/ha in one study area) in dense mature stands (Griffin and Mills 2009, pp. 1492-1496). Over a longer interval (1999-2003) when hare populations in this area were thought to be stable (Squires and Ruggiero 2007, p. 314), mean summer and winter hare densities, respectively, were 0.34 hares/hectare (ha) and 0.53/ha in dense mature stands and 0.64/ha and 0.47/ha in dense young stands – habitats selected by lynx, compared to 0.18/ha and 0.20/ha in open mature stands and 0.18/ha and 0.12/ha in open young stands that lynx did not select (Squires and Ruggiero 2007, pp. 313-314). Even the relatively higher hare densities in the dense mature and dense young stands only marginally achieve the threshold density of 0.5/ha thought necessary to support lynx within home ranges (Ruggiero *et al.* 2000b, pp. 446–447; ILBT 2013, pp. 24, 26, 90). Nonetheless, hares accounted for 96 percent of the biomass in lynx diets in this unit based on evidence at kill sites (Squires and Ruggiero 2007, pp. 310-313), suggesting that even small declines in landscape-level hare densities could reduce the ability of habitats in this unit to support resident lynx (Squires *et al.* 2010, p. 1656).

Lynx in this unit generally den in mature spruce-fir forests among downed logs or root wads of wind-thrown trees in areas with abundant coarse woody debris and dense understories with high horizontal cover in the immediate areas around dens (Squires *et al.* 2004a, Table 3; Squires *et al.* 2008, pp. 1497, 1501–1505). Few dens are located in young regenerating or thinned stands with discontinuous canopies (Squires *et al.* 2008, p. 1497). Many dens have northeasterly aspects and are farther from forest edges than random expectation (Squires *et al.* 2008, p. 1497).

Average annual snowfall in this unit ranges from about 142 cm (56 in) in the Kalispell/ Whitefish/ West Glacier area of northwestern Montana to 183 cm (72 in) in Nordman in northern Idaho, to 216 cm (85 in) in Lincoln, Montana, near the southern end of the unit, to 259 cm (102 in) in Rexford, Montana near the Canada - U.S. border, to 345 cm (136 in) in Seeley Lake, Montana, in the central part of the unit, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 4/2/2016).

Habitat Status: Lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 84 percent (22,761 km^2 [8,788 mi^2]) of this unit is in federal ownership, including 18,695 km^2 (7,218 mi^2) in national forests under USFS management, 3,658 km^2 (1,412 mi^2) in Glacier National Park managed by NPS, and 397 km^2 (153 mi^2) managed by BLM in its Garnet Resource Area. As described above, potential lynx habitat in this unit is patchily- distributed and interspersed with areas of non-habitat (matrix). Among the six national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 54 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123). In Glacier National Park, 2,976 km^2 (1,149 mi^2; about 73 percent of the park) is considered “lynx forest types” (65 FR 16073), but only 1,103 km^2 (426 mi^2; 27 percent of the park, 37 percent of lynx forest types) is estimated to be lynx habitat (68 FR 40086, 40089). In the Garnet Resource Area, the BLM designated five LAUs (which approximate a lynx home range) covering 947 km^2 (366 mi^2), of which, 574 km^2 (222 mi^2; about 61 percent) was mapped as lynx habitat (Sparks 2016a, pers. comm.).

Federal lands are managed as either ‘‘developmental’’ or ‘‘nondevelopmental’’ land use allocations (68 FR 40093). Lands in developmental allocations are managed for multiple uses, such as recreation and timber harvest, some of which may conflict with lynx conservation. Management within non-developmental allocations focuses on the maintenance of natural ecological processes, or conservation of rare ecological settings or components, and these areas include wilderness, roadless, and semi-primitive non-motorized areas (USFWS 2007, pp. 33, 77). Timber harvest, road construction, and fire suppression typically do not occur or are very limited in lands managed in non-developmental allocations.

In this SSA unit, almost 46 percent of the federal land and 40 percent of the entire unit is in designated wilderness or national park land, including (in addition to Glacier National Park) the 6,297-km^2 (2,431-mi^2) Bob Marshall Wilderness Complex (Bob Marshall, Great Bear, and Scapegoat wilderness areas) on the Flathead, Lewis and Clark, Helena and Lolo national

forests, the 302-km^2 (117-mi^2) Mission Mountain Wilderness on the Flathead National Forest, the 139-km^2 (54-mi^2) Rattlesnake Wilderness Area on the Lolo National Forest, and the 371-km^2 (143-mi^2) Mission Mountain Tribal Wilderness on the Flathead Reservation. Management of NPS lands and both national forest and Tribal wilderness areas provides restrictions on land use beneficial to lynx (65 FR 16073; USFWS 2014, pp. 28-29; 79 FR 54831), and adverse effects of management activities on lynx habitats in these areas are unl kely. Among the six national forests that contribute to this unit, 56 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34).

Much of the remaining USFS lands and the BLM lands have developmental land-use allocations where some management activities have the potential to impact lynx or its habitat. However, as described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2004 amended the Resource Management Plan (RMP) for the Garnet Resource Area to incorporate the conservation measures identified in the LCAS (BLM 2004a, 2004b, entire; Sparks 2016b, pers. comm.). Both documents provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently- applied framework for conserving and restoring important hare and lynx habitats.

Habitat status on private lands, which account for about 8 percent of lands in this unit (2,172 km^2 [839 mi^2]), is governed by some federal and State regulations and buy a number of private-public conservations partnerships and State agency efforts. As described in section 3.1., above, some federal and State regulations guide some activities on private lands, including the ESA's prohibition on take of listed species, and State regulations governing trapping and timber management. In addition to these protections, there have been several other notable lynx conservation achievements on private lands in this unit since the DPS was listed. Two of these, the Clearwater-Blackfoot Project and the Montana Legacy Project, are multi-partner and community efforts led by The Nature Conservancy in Montana to purchase large tracts of private commercial timberlands, conveying some to the State of Montana and the USFS for conservation management, and acquiring conservation easements on others (TNC 2016a, 2016b, 2016c, entire). These land acquisitions have resulted in protection of roughly 673 km^2 (260 mi^2) of important lynx habitat within this SSA unit and another 583 km^2 (225 mi^2) just to the south and west that may occasionally or temporarily support lynx or provide dispersal habitat. Additionally, the MTFWP has acquired fee title or conservation agreements on 3,096 km^2 (1,195 mi^2) of private lands in western Montana, including 162 km^2 (63 mi^2) in designated lynx critical habitat in this SSA unit, with ongoing efforts on another 106 km^2 (41 mi^2) in the northwest part of the unit (MTFWP 2016, pp. 1, 3).

In addition to the MTFWP's efforts to acquire private lands and protect them through fee title or conservation agreement, the State of Montana has also worked to protect lynx habitat on State-owned lands, which account for about 4 percent of the lands in this unit (1,106 km^2 [427 mi^2]). As described above in section 3.1.2, the MTDNRC worked closely with the Service to develop the *State of Montana Department of Natural Resources and Conservation Forested State Trust Lands Habitat Conservation Plan* (MTDNRC HCP; MTDNRC and USFWS 2010a, 2010b, 2010c, entire); a multi-species HCP that focuses primarily on commercial forest management. The HCP includes a Lynx Conservation Strategy that minimizes impacts of forest management activities on lynx, describes conservation commitments that are based on recent information from lynx research in Montana, and commits to active lynx monitoring and adaptive management programs. The HCP covers about 2,220 km^2 (857 mi^2) of forested State trust lands in western Montana, including 703 km^2 (271 mi^2) within this SSA geographic unit (about 64 percent of State lands in this unit). The goal of the HCP's Lynx Conservation Strategy is to support federal lynx conservation efforts by managing for habitat elements important to lynx and their prey that contribute to the landscape-scale occurrence of lynx. Specific objectives to achieve this goal include protecting den sites and potential denning habitat, mapping and maintaining lynx foraging habitats and limiting the spatial and temporal scope of their conversion to unsuitable conditions from forest management activities, and providing for habitat connectivity (MTDNRC and USFWS 2010b, pp. 2-45 - 2-61). The HCP was finalized and permitted by the Service in 2011, and includes a 50-year commitment by the State to manage for lynx conservation on these lands (79 FR 54835-37).

Tr bal lands of the Flathead Reservation account for almost 4 percent of this unit. In addition to the Tribe's approach to lynx management described in section 3.2.1, above, most lynx and lynx habitat on the reservation occur in areas with formal protective status, including: (1) The long-designated Mission Mountains and Rattlesnake Tr bal Wilderness Areas, which are largely roadless and managed for wilderness qualities; (2) the South Fork/Jocko Primitive Area, which is open to use only by Tribe members and in which commercial timber harvest is prohibited; and (3) the Nine-mile Divide country, which is marginal in terms of lynx habitat, but which is also partly roadless (Courville 2014, pers. comm.; 79 FR 54831).

As elsewhere in the DPS, winter foraging habitat is thought to be the most limiting habitat for lynx in this unit (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27). As described above, lynx selected mature multistoried stands with dense horizontal structure and relatively higher winter hare densities (Squires *et al.* 2010, pp. 1648, 1653–1656). Because of this preference, the Forest Service in the NRLMD adopted a vegetation management standard (VEG S6) that precludes all vegetation management activities that could reduce winter snowshoe hare habitat in multistoried forests, not just precommercial thinning as recommended in the LCAS (USFS 2007, pp. 13-14). Also as elsewhere (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517, ILBT 2013, p. 30; 79 FR 54790), denning habitat is not thought to be a limiting factor for lynx in this unit (Squires *et al.* 2008, p. 1505). Nonetheless, the NRLMD includes guidance to ensure adequate denning habitat remains well distributed in LAUs and, therefore, across the larger landscape and to design projects to create or retain coarse woody debris in areas where denning habitat may be lacking (USFS 2007, p. 17). Snow conditions in this unit

also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America, showing that this geographic unit has a 90-95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

Overall, although naturally fragmented and patchily-distributed, lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway) development and evidence of minor genetic differentiation among lynx subpopulations (see *Lynx Status*, below), past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

A possible exception may be in the Garnet Mountains, which are known to have supported a small number of resident lynx in the 1980s and recently from 2002-2010, but where more recent surveys and research trapping efforts have failed to detect lynx (Squires *in* Lynx SSA Team 2016, p. 20; also see Lynx Status, below). This small and relatively isolated island of lynx habitat (Squires 2014, p. 4) at the southern end of this unit is thought to be capable of supporting 7-10 lynx home ranges (Squires 2016, pers. comm.). The BLM (2004, pp. 4-5) contrasted current and historical distributions of lynx habitats in the Garnets and found that early- successional stands (future hare and lynx foraging habitats) were at 25-50 percent of the historic condition in lower- elevation (1,370-1,830 m [4,500-6,000 ft]) lynx habitats, and 10-30 percent in higher- elevation (1,675-2,130 m [5,500-7,000 ft]) habitats. Late- successional (mature multistoried) stands (25-75 percent of historical condition) and large (> 100 ha [250 ac]) patches (25-50 percent of historical condition) were also underrepresented at lower elevations, but at higher elevations, late- successional stands and large patches exceeded 200 percent and 100 percent of historical conditions, respectively. Lower elevation habitats were fragmented by roads and past management practices (i.e., timber harvest), while higher-elevation habitat patterns were attributed to the absence of disturbance, including fire (BLM 2004, p. 5), though fire absence was not attributed to suppression.

As discussed for the GYA in section 2.3.2.2, above, whether the recent absence of lynx in the Garnets represents the extirpation of a previously- persistent small resident population (and, therefore, a contraction in the range of resident lynx in this unit) or a temporary “winking off” of a small peripheral population that would be expected in a mainland-island metapopulation structure is uncertain and perhaps irresolvable. If residency was intermittent historically, the current absence of lynx might be a natural condition related to the area’s naturally fragmented habitats and generally low hare densities - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. If so, future intermittent lynx occupancy would be expected, but only if lynx dispersing from a source

population immigrate to the Garnets when habitat conditions and hare densities return to more favorable levels. Conversely, if the Garnets historically supported a small but persistent population that was recently extirpated, it may suggest that the alteration of the historic distribution of some habitats in some parts of the range, descr bed above, was enough to tip the quality of the area's habitat from capable of supporting a small resident population to no longer capable of doing so.

In summary, almost all lands in this unit are managed to conserve lynx and hare habitats in accordance with federal, State, and Tribal regulations and management direction, conservation easements, and an approved HCP. Much of the area consists of designated federal and Tribal wilderness areas and other nondevelopmental land use allocations, where management activities with the potential to adversely affect lynx generally do not occur. On lands with development allocations, USFS, BLM, and State management are based on plans that incorporate the conservation guidance identified in the LCAS as informed by more recently-available scientific information. The State and TNC, working with other conservation partners, have bought or acquired conservation easements on large tracts of high-quality private lands in the unit that are known or suspected to be occupied by resident lynx. These efforts and management across multiple ownerships likely preclude landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places, as described above for the Garnet Mountains. Because lynx habitats in this unit, like most other areas of the DPS range, are naturally highly-fragmented, and most have hare densities that barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit although, as described in section 2.3.2.2 above, it is thought to be capable of supporting perhaps 200-300 lynx (Squires *in* Lynx SSA Team 2016, p. 41). This is substantially fewer than previous estimates of more than 1,000 lynx, which were based on a habitat area/ density index and broad assumptions regarding habitat suitability and lynx distribution (65 FR 16058) that are not supported by current understanding of lynx habitat requirements. As described above, habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Although the exact distribution of resident lynx remains uncertain, this unit has a long and continuous history of lynx occurrence and evidence of reproduction (McKelvey *et al.* 2000, pp. 224-225; Squires and Laurion 2000, pp. 346-348; Squires *et al.* 2008, entire; Squires *et al.* 2013, entire; ILBT 2013, p. 57; 65 FR 16058; 68 FR 40090; 74 FR 8643; 79 FR 54825). Genetic analyses revealed minor fine-scale genetic sub-structuring among lynx subpopulations in the southern (Garnets), central (Seeley Lake), and northern (Purcells) parts of this unit, suggesting limited interaction among lynx in those areas (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5; Squires *in* Lynx SSA Team 2016, p.

20). Lynx in this unit likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia, but the extent to which lynx persistence in this area may rely on immigration from Canada is unknown, and there is no indication of substantial immigration (irruptions) of lynx from Canada into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20).

From 1998 to 2007, researchers with the Forest Service's Rocky Mountain Research Station in Missoula trapped and radio-marked 175 lynx in northwestern Montana and collected nearly 170,000 GPS and over 3,000 VHS telemetry locations documenting lynx movements, resource use, survival, and productivity (Squires *in* Lynx SSA Team 2016, p. 20). From 1999-2007, litter sizes averaged 2.24 kittens/litter (N = 33) in the Seeley Lake area and from 2003-2007, 2.95 kittens/litter (N = 22) in the Purcell Mountains. In Seeley Lake, 61 percent of breeding-age females (N = 52) produced kittens; in the Purcells, 83 percent of females (N = 28) produced kittens. Recent research (Kosterman 2014, entire) suggests that the probability that a female produces a litter and initial litter size are correlated positively with mature forest connectivity and negatively with fragmentation in female home ranges (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix A). Annual survival rates for subadult and adult female lynx were 0.52 and 0.75, respectively, in Seeley Lake, and 0.68 and 0.85, respectively, in the Purcells. There was no evidence of cyclicity in these vital rates, and no indication of substantial immigration of lynx into these study areas from Canada. Starvation, predation by mountain lions, and human-caused deaths each accounted for roughly one-third of documented sources of lynx mortality. Population viability analyses yielded population growth rates (λ) of 0.92 for the Seeley Lake area (i.e., declining population trend, 1999-2007) and 1.16 for the Purcells (increasing trend, 2003-2007). However, as described in section 2.2.2, above, estimates of λ in a cyclic Canadian population of lynx ranged from 2.03 (annual doubling) when hares were abundant to 0.10 (order of magnitude decline) after hare populations crashed (Slough and Mowat 1996, p. 952, Table 4), and the natural range in λ that would be expected among peripheral, isolated, or semi-isolated and non-cyclic or weakly-cyclic lynx populations in the DPS versus those that would signal long-term population decline or instability is unknown.

As described above, lynx distribution in this unit may have contracted with the recent apparent disappearance of resident lynx from the Garnet Mountains in the southern part of the unit. Lynx were documented in the Garnets in the 1980s and from 2002-2010, but no lynx were detected during snow-track and camera-trap surveys in winter 2014-2015 (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix 5). This area is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.); 5 lynx were monitored via telemetry in 2002, 3 in 2003-2004, 2 in 2005, and single lynx each year in 2006, 2007, and 2010 (Squires *in* Lynx SSA 2016, Appendix 5 [2015 10 14 - 8, p. 26]). As described in section 2.3.2.2 and above, whether the recent absence of lynx from this part of the unit represents the extirpation of a small but previously persistent population (and, therefore, a permanent contraction of lynx distribution in this unit) or the temporary "winking off" of a peripheral subpopulation that may become "winked on" again in the future is unknown and perhaps irresolvable.

Snow-tracking, hair-snare, and camera-trap surveys in other parts of this unit since the DPS was listed continued to detect lynx on the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests (USFS 2015, pp. 9-27). On the Flathead, the USFS Rocky Mountain Research Station(RMRS) trapped and radio-marked 7 lynx (3 females, 4 males) in the Flathead River watershed from 2010-2015, and surveys detected lynx in several other areas including the Salish Mountains, the area just south of Glacier National Park, and in the vicinity of Hungry Horse Reservoir (USFS 2015, pp. 10-11). The Swan Lake District in the southern part of the Flathead, along with the Seeley Lake District of the Lolo National Forest and the Lincoln District of the Helena National Forest, is part of the 6,070-km^2 (2,344-mi^2) Southwestern Crown of the Continent, which was intensively surveyed from 2012-2014 by the Southwestern Crown Carnivore Monitoring Team (SCCMT 2014, entire). The SCCMT conducted snow track surveys and used hair snares, bait stations, and camera traps to detect lynx in 36 of the 82, 8 x 8 km (5 x 5 mi) grid cells they surveyed (SCCMT 2014, pp. 3, 17-20). The surveys resulted in collection of DNA that allowed identification of 18 individual lynx (5 females, 13 males), 13 of which were new to regional lynx databases (SCCMT 2014, pp. 3, 17-20).

On the Helena National Forest, few lynx have been detected outside the Lincoln District/ Southwest Crown descr bed above. In the south MacDonald Pass area, just south of this SSA unit and south of designated critical habitat, an individual male lynx was verified by DNA evidence over four winters (2007-2011), and an individual female was verified in the same area in the winter of 2008-2009 (Gehman *et al.* 2011, p. 21; USFS 2015, p. 27). Other surveys on the Helena failed to detect lynx in the disjunct Big Belt and Elkhorn Mountains, although telemetry data indicated that three lynx released in Colorado passed through the Big Belts in 2004-2006 (USFS 2015, pp. 26-27). Likewise, during snow tracking surveys on the Lolo in 2010-2011 (prior to the Southwestern Crown monitoring described above), lynx were also confirmed on the Seeley Lake District in the eastern part of the forest, but no lynx were documented on the Missoula or Ninemile districts, nor on the Superior and Plains/Thompson Falls districts in the western part of the forest (USFS 2015, pp. 12-14). The USFS concluded that lynx presence in districts other than Seeley Lake is extremely rare and likely represents occasional dispersing lynx (USFS 2015, p. 21).

On the Kootenai National Forest, RMRS research efforts continued to document the long-term presence of lynx, where trapping and radio-marking efforts yielded 50,000-60,000 lynx telemetry locations from 2003-2012 (USFS 2015, p. 10). On the Lewis and Clark National Forest, lynx are considered “still present” in the Rocky Mountain Front portion of the forest, which is within this geographic unit and designated critical habitat, and snow track surveys from 2010-2013 in the disjunct Little Belt and Crazy Mountains documented the continued absence of resident lynx in those ranges (USFS 2015, pp. 25, 27-34). On the Idaho Panhandle National Forest, surveys detected individual lynx in the Selkirk Mountains in 2010 and 2011 and in the Purcell Mountains in 2012. All detections were within 15 miles of the Canada-U.S. border (USFS 2015, p. 10). No lynx were detected during surveys in 2007 or 2013-2014, and snow surveys were not done in 2015 because of poor snow conditions (USFS 2015, p. 9). However, in 2012-2014 three lynx were incidentally trapped on the Idaho Panhandle (one in 2012 in the Purcells, and two in 2014

in the Cabinet Mountains), and another was documented by a Service grizzly bear trapping crew in the Purcells in 2014 (USFS 2015, pp. 9-10; U.S. District Court ID 2016, pp. 6-7).

In summary, although the number of lynx in this geographic unit is uncertain, resident lynx appear to remain broadly distributed throughout most of the unit. The recent apparent absence of lynx in Garnet Mountains may indicate extirpation of a small resident population and a contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure. Lynx are rarely detected on surveys on other national forests (or parts of those above) that are outside but adjacent to this geographic unit (Patton 2006, entire; USFS 2105, pp. 1-9, 25-34), suggesting that these areas lack the habitat features and/or landscape-level hare densities necessary to support resident lynx populations (79 FR 54818-54820).

Factors Affecting Current Conditions: *Regulatory Mechanisms* - Federal management activities (especially timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. For example, as described above in *Habitat Status* and *Lynx Status*, past timber harvest/management and associated road construction may have fragmented, reduced the amount, and altered the distribution of lynx habitats in the Garnet Mountains, perhaps contributing to the apparent recent loss of that area's ability to support resident lynx.

Currently, as described above and in section 3.1, all federal and Tribal lands, most State lands, and large blocks of private or formerly-private land in this unit are managed for the conservation of lynx habitats, and much of the unit is in designated wilderness or other nondevelopmental land-use allocations. Regulatory mechanisms and conservation measures associated with these management strategies are intended to conserve and restore lynx and hare habitats across large landscapes and multiple ownerships. Although their effectiveness has not be quantitatively evaluated, and despite the potential extirpation of a small population in the Garnets, lynx habitats and resident lynx appear to remain well distributed throughout most of this unit.

Other regulations prohibit lynx trapping and require measures to reduce the l kelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, 16 lynx are documented to have been incidentally trapped in Montana, with 13 of those occurring before 2008, when more protective regulations were put in place (MTFWP 2016, pp. 5-10). Of the 16, eight were released uninjured, one was released with an injury, and seven were killed; all incidences of mortality occurred prior to 2008 and the implementation of the more protective regulations (MTFWP 2016, p. 5). In Idaho, in addition to the three lynx incidentally trapped on the Idaho Panhandle National Forest from 2012-2014 (described above under *Lynx*

Status), one other lynx was incidentally trapped in 2012 on the Salmon-Challis National Forest further south (U.S. District Court ID 2016, p. 6).

Although lynx are legally trapped in Canada adjacent to this unit in southern Alberta and southern British Columbia, trapping there is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Environment Canada 2014, entire; Vashon 2015, pp. 5-6). Lynx harvest in Alberta varied from about 4,000 to 14,000 annually in the late 1970s and early 1980s, but declined to fewer than 2,000 for most years from 1984-2000, and restrictive quotas and season closures were implemented beginning in the late 1980s (Poole and Mowat 2001, pp. 16, 28). Similarly, harvests in British Columbia peaked at over 12,000 in the early 1960s and over 8,000 in the early 1970s, then declined to fewer than 2,000 for most years from the mid-1980s until the year 2000 (Hatler and Beal 2003, p. 2). Whether, and if so to what extent, trapping in Canada may influence lynx dispersal across the border and into this geographic unit is unknown; however, such dispersal was documented historically when harvest levels in Canada were much higher than under current management.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Hall and Fagre 2003, entire; Mote 2003, entire; Fagre 2005, entire; Knowles *et al.* 2006, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Squires *in* Lynx SSA 2016, p. 20; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities, even in areas considered high-quality habitat for this DSP unit, often appear to barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 90-95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et*

al. 2010. pp. 607, 609). Although insect outbreaks have affected some parts of the DPS, no major outbreaks have been documented in lynx habitats in this unit (Lynx SSA Team 2016, p. 41).

Vegetation Management - As elsewhere in the DPS range, timber harvest and related vegetation management (precommercial thinning and other silvicultural techniques designed to optimize forest products outputs; ILBT 2013, pp. 71-72) are the dominant land uses potentially affecting lynx habitats in this unit (68 FR 40075, 40092; 79 FR 54825). As descr bed in section 3.3, above, these activities can reduce hare and lynx habitats by reducing horizontal cover and altering natural disturbance regimes and forest successional patterns. In this unit, precommercial thinning was shown to reduce short-term hare abundance (Griffin and Mills 2007, entire) and appeared to influence lynx movements (Squires *et al*. 2013, p. 192-194), and lynx rarely traveled across recent clearcuts or other large openings, especially in winter (Squires *et al.* 2010, p. 1654; ILBT 2013, p. 77). However, as described under *Habitat Status*, above, these activities on federal lands, which account for most of the lands in this unit, occur only on lands with developmental allocations and historically appear to have impacted only a small proportion of potential lynx habitats in this unit (65 FR 16072; 68 FR 40093). Additionally, timber harvest levels on federal lands in the West, including the Northern Rockies, and specifically with regard to “lynx forest types,” had declined consistently and dramatically for a decade or longer prior to the DPS being listed (68 FR 40093), and have remained at levels much lower than those from most of the previous century. Despite some likely localized impacts, past vegetation management does not appear to have broadly diminished this unit's ability to support resident lynx, although, as described above, it may have contributed to the current absence of a small number of resident lynx from the Garnet Mountains. Also as descr bed above, current vegetation management in this unit on all federal, most State and Tribal, and some private lands, is conducted in accordance with formally amended USFS and BLM management plans, an approved State HCP, Tribal regulations, and conservation easements designed to avoid or minimize impacts to lynx habitats, especially important hare and lynx winter foraging habitats.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, where about 15 percent (4,172 km^2 [1,611 mi^2]) of the unit has burned from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20), likely in response to climate warming and related increases in drought conditions (e.g., Harvey *et al.* 2016, entire; Westerling 2016, entire). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit’s ability to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction. In the Northern Rocky Mountains, the forests upon which lynx depend have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and

these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx (with the poss ble exception of the Garnet Mountains). Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Idaho (1) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unl kely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. This unit is directly connected to lynx habitats and populations in southwestern Alberta and southeastern British Columbia, where lynx habitats are also (like Montana and Idaho) patchily-distr buted and generally support low hare densities, and where some lynx populations may be ephemeral and the persistence of others reliant on periodic influx of immigrants (Apps 2007, pp. 81, 95-104). Additionally, connectivity between this geographic unit and lynx habitats and populations in southern Alberta and southern British Columbia may be facilitated by only a few predicted corridors that extend south from the international border (Squires *et al.* 2013, pp. 187, 191-193).

Although lynx occurrence and harvest records in this geographic unit reflect the unprecedented irruptions of lynx from Canada into the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 224-226, 232-242), there is no evidence of irruptions of lynx into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). This is supported by lynx trapping records from Canada, which suggest that the magnitude of lynx populations cycles in Alberta and British Columbia dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Poole and Mowat 2001, p. 28; hatler and Beal 2003, p. 2; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which would be expected to alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a

gradual decline of a resident lynx population that needs but is not receiving adequate immigration. In contrast, the growth rate estimated for the lynx population in the Purcell Mountains in the northwestern part of this unit (λ = 1.16, increasing trend 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) suggests that the level of immigration, if necessary for demographic stability, has been adequate or that productivity and recruitment have been high enough to offset potentially diminished immigration. It is also possible that, despite the documented historical intermittent (cyclic) influxes of lynx from Canada into lynx populations in this geographic unit, immigration does not contribute meaningfully to the demographic stability of these populations. If that is the case, the estimated growth rates suggest that recruitment has failed to offset mortality in the Seeley Lake population but that it has more than done so in the Purcell Mountains population.

4.2.4 Unit 4 - North-central Washington

Unit Description: This geographic unit is located in the northern Cascade Mountain Range of north-central Washington in portions of Chelan and Okanogan Counties and includes mostly Okanogan-Wenatchee National Forest lands as well as BLM lands in the Spokane District that were designated as critical habitat (Unit 4) for lynx in 2014 (79 FR 54825). The unit also includes State Forest lands (portion of the Loomis State Forest) that were excluded from designation as critical habitat (79 FR 54825). It encompasses approximately 5,176 km^2 (1,988 mi^2), with ownership that is 91.5 percent federal (USFS, BLM), 8.2 percent State, and 0.3 percent private lands; there are no Tribal lands. This area was occupied at the time lynx was listed and is currently occupied by the species. Evidence from recent research and DNA analysis shows lynx distributed within this unit, with breeding being documented. Although researchers have fewer records in the portion of the unit south of Highway 20, this area contains boreal forest habitat and the components essential to the conservation of the lynx. Further, it is contiguous with lynx habitat north of Highway 20, particularly in winter when deep snows close Highway 20. The northern portion of the unit adjacent to the Canada border also appears to support few recent lynx records; however, it is designated wilderness, so access to survey this area is difficult. This northern portion contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia directly north of this unit.

As it is throughout the range of lynx in the contiguous U.S., maintaining connectivity with Canada is important to lynx populations in northern Washington and the Cascade Mountains. Singleton *et al.* (2002, entire) evaluated landscape permeability for large carnivores in Washington. They reported broad landscape permeability for lynx between the Thompson River watershed in British Columbia and the U.S. portion of the northern Cascades (Singleton *et al.* 2002, p. 46). According to the LCAS, connectivity currently appears functional, as lynx dispersal from Washington into Canada was recently documented. A male lynx radio-collared in 2008 in the Loomis State Forest remained there until late winter in 2009, when it dispersed north into Canada toward Hope, British Columbia, and then headed north-east toward Kamloops where it appeared to establish a home range just southeast of Kamloops. This individual was later

trapped and killed in British Columbia, highlighting the need for cooperation and shared management goals across political boundaries (LCAS 2013, p. 65).

Several areas adjacent to this geographic unit (e.g., Kettle Range, the Wedge, Little Pend Oreille, Se kirk Mountains of northeast Washington) are known or thought to support a small number of lynx, at least intermittently. One of these areas in particular (Kettle Range) contains the second largest block of potential lynx habitat in Washington comprising approximately 987 km^2 (381 mi^2), which is significantly smaller than the North Cascades that supports approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (Stinson 2001, p. 18). Historically, although the Kettle Range supports a fairly small block of lynx habitat (relative to other geographic areas supporting persistent lynx populations), it was considered to be a stronghold for lynx in Washington (Stinson 2001, p. 14). The Kettle Range was suspected to have supported a resident population until about 30 years ago when over-trapping may have resulted in their extirpation from the mountain range (Koehler *et al.* 2008, p.1523). For example, lynx were consistently trapped in the Kettle Range in the 1960s, 1970s, and 1980s. In the Kettle Range, a total of 81 lynx were trapped from 1961 through 1986. One lynx was harvested in 1963, 3 in 1966, 7 in 1967, 2 in 1969, 26 in 1970, 14 in 1976, and 17 in 1977. A single lynx was taken each year in 1980, 1983, 1985, and 1986 (Stinson 2001, p. 63). Prior to 1961, lynx trapping records were not maintained in Washington. Beginning in 1978, trapping seasons in Washington for lynx were reduced to one month. In 1987 a restricted permit system was implemented, and in 1990 a statewide closure on lynx trapping was implemented (Service 2008).

Lynx habitat in the Kettle Range is limited in size and capable of supporting few lynx. According to Koehler *et al.* (2008, p. 1523), the Kettle Range could support between 10 to 23 lynx based upon a lynx density of 2.3 lynx/100km^2 and 400 km^2 (154 mi^2) to 987 km^2 (381 mi^2) of lynx habitat. It should be noted that the lynx density estimate was derived from research conducted in the Cascade Range within a large area of contiguous, high quality habitat (Koehler 1990, pp. 845, 847). Lynx habitat in the Kettle Range is much smaller and likely more fragmented, and thus may not be capable of supporting a density of 2.3 lynx/100 km^2. The Kettle Range is also somewhat isolated from other lynx habitats in Washington (e.g., the Cascades) and British Columbia. The Kettle Range is separated from the Cascades in Washington by low elevation valleys dominated by shrub-steppe and Douglas-fir and ponderosa pine forests (Koehler *et al.* 2008, p. 1523), and from British Columbia by the Kettle River Valley (Stinson 2001, p. 20) and a major highway corridor with associated fence in British Columbia (Koehler *et al.* 2008, p. 1523). These natural topographic and anthropogenic features may present impediments to lynx movement between the Kettle Range and the Cascades and British Columbia, making natural recolonization of the Kettle Range by lynx difficult. Thus, it may be difficult for lynx to reestablish a persistent and viable resident breeding population in the Kettle Range.

Habitat Description: In the northern Cascades most lynx occurrences are associated with the Rocky Mountain Conifer Forest (Aubry *et al.* 2000, p. 379; McKelvey *et al.* 2000, p. 246) at elevations between 1,400 m (4,593 ft) and 2,150 m (7,053 ft) (McKelvey *et al.* 2000, p. 322; Stinson 2001, p. 9). Within this area lynx primarily use forests dominated by Engelmann spruce,

subalpine fir, or lodgepole pine on mild to moderate slopes (less than 30 degrees), and avoid Douglas-fir and ponderosa pine forests, forest openings, recently burned areas with sparse canopy and understory cover (less than 10 percent), low elevations [less than 915 m (3,000 ft)], and steep slopes (greater than 30 degrees) (Koehler *et al.* 2008, pp. 1518, 1521; Maletzke 2004, pp. 16-17). Similar to the northern Rocky Mountains, lynx habitat in the Cascades is naturally fragmented (Koehler *et al.* 2008, p. 1523). Disturbance is common in boreal forests, and fires and insect epidemics are major drivers of this disturbance, but other factors including wind and disease also contribute to the process of disturbance (Agee 2000, p. 47). Fire return intervals in the north Cascades ranges between approximately 100 to 250 years (Agee 2000, p. 50).

Snowshoe hares are the primary prey of lynx throughout their range in North America (Mowat *et al.* 2000, p. 267) comprising 35-97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Lynx also consume other prey species, including red squirrels, mice, voles, grouse, ptarmigan, and other species of mammals and birds, especially during summer or when snowshoe hare population densities decline (Mowat *et al.* 2000, pp. 267-268). Koehler (1990, p. 848) found snowshoe hares were the primary prey of lynx in the north Cascades of Washington occurring in 23 of 29 (79 percent) lynx scats examined, but the remains of red squirrels were identified in 7 of the 29 (24 percent) lynx scats, as were the remains of other species including deer and mice. Von Kienast (2003, p. 39), who also conducted a lynx study in the north Cascades of Washington, found snowshoe hares in 87% (40 of 46) of lynx scats, while red squirrels were identified in 28% (13 of 46) of lynx scats.

Results of lynx research in the northern portion of its range suggest that a minimum density of 0.5-1.0 hares/ha (0.2-0.4 hares/ac) is needed to support lynx reproduction, but it is unknown if a similar snowshoe hare density is required to support lynx reproduction in the southern portion of its range (Ruggiero *et al.* 2000b, p. 446). In the northern portion of lynx range (i.e., the taiga) peak snowshoe hare densities regularly exceed 4-6 hares/ha (1.6-2.4 hares/ac), and cycle as low as 0.1-1 hares/ha (0.04-0.4 hares/ac) (Hodges 2000, pp. 119-120). In the southern portion of lynx range (e.g., the U.S.) snowshoe hare densities are low compared to those in northern regions (Aubry *et al.* 2000, p. 375). Walker (2005, p. 20) estimated an average snowshoe hare density of 0.89 hares/ha (0.36 hares/ac) with a range of 0.03 to 4.85 hares/ha (0.01 to 1.94 hares/ac) in north central Washington (i.e., the Cascades). The Washington Department of Natural Resources (WADNR) found snowshoe hare densities between 0.3 and 0.7 hares/ha (0.1 and 0.3 hares/ac) on the Loomis State Forest (WADNR 2006, p. 87).

Lynx distribution is nearly coincident with the distribution of snowshoe hares (McCord and Cardoza 1982, entire; Bittner and Rongstad 1982, entire), and lynx occupy habitats where snowshoe hares are abundant (Koehler and Aubry 1994, p. 84). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448). Average annual snowfall is consistent throughout this unit and is approximately 291 cm (114.5 in) (https://snowfall.weatherdb.com/d/a/Washington; accessed 4/27/2016).

Habitat Status: The range of lynx in the contiguous U.S. is broadly delineated by the distribution of the southern extensions of boreal forest. However, the complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with naturally dynamic habitat, make it difficult to precisely delineate the historic range of lynx in the U.S. (68 FR 40084). McKelvey *et al.* (2000, pp. 245-246) described the historic range of lynx in the western U.S., encompassing at least 75 percent of lynx occurrences, as associated with the Rocky Mountain Conifer Forest containing the primary vegetation types of Douglas-fir and western spruce/fir forests. These western spruce fir forests represent the southern extension of boreal forests into the U.S. (Agee 2000, pp. 40-42, 46). The amount of boreal forest habitat in the contiguous U.S. has not changed substantially in the past 100 years (68 FR 40085).

However, while the boreal forest may not have changed substantially within the past 100 years (i.e., permanent or long-term reductions in the quantity or size), it is naturally dynamic with fire and insects representing major disturbance processes (Agee 2000, p. 47) that can create areas temporarily unsuitable for lynx through regeneration of forested stands to early successional conditions (Agee 2000, pp. 62-63). In 2001, the Washington Department of Fish and Wildlife (WDFW) estimated there was approximately 8,923 km^2 (3,445 mi^2) of potential lynx habitat within this geographic unit. Several wildfires affected lynx habitat in the north Cascades during the middle 1990s and early 2000s: 1994 Whiteface Burn (1,554 ha (3,840 ac)); 1994 Thunder Mountain Fire (3,686 ha (9,108 ac)); 2001 Thirty-Mile Fire (2,565 ha (6,338 ha)); and 2001 Farewell Fire (32,278 ha (79760 ac)) (Vanbianchi 2015, p. 23). Subsequent to these fires and incorporating new science on lynx habitat use, Koehler *et al.* (2008, pp. 1521-1522) estimated this geographic unit contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on studies conducted from 2002 through 2004. More recent wildfires, including the 2006 Tripod Fire (70,644 ha (175,656 ac)) (Vanbianchi 2015, p.23), have affected approximately 1,000 km^2 (386 mi^2) of lynx habitat within this geographic unit (Lynx SSA Team 2016, p. 21). Cumulatively, over the past 2 decades these wildfires have burned greater than 50 percent of the suitable lynx habitat within this geographic unit (Koehler *et al.* 2008, p. 1523). These acres are expected to regenerate back into suitable lynx habitat, but it may take several decades for this to occur.

Lynx Status: In Washington, there is little information on the status of the lynx population prior to the early 1960s (Stinson 2001, p. 13). From 1960-61 to 1990-91 a total of 234 lynx were harvested in Washington, with the most lynx trapped in Ferry County (35 percent of the 234), followed by Okanogan (23 percent) and Stevens (10 percent) counties (Stinson 2001, p. 13). The WDFW identified six lynx management zones (LMZs) in Washington: Okanogan, Vulcan-Tunk, Kettle Range, The Wedge, Little Pend Oreille, and Salmo-Priest (i.e., essentially the Selkirk Mountain Range in northeast Washington (Stinson 2001, p 14). In 2001, the WDFW considered lynx to be present in the Okanogan, Kettle Range, Little Pend Oreille, and Salmon-Priest LMZs; at that time lynx had not been detected in the Wedge LMZ since 1987 nor the Vulcan-Tunk LMZ since 1990 (Stinson 2001, p.15).

In 2001, based on data collected from lynx telemetry studies conducted in the Cascade Range during the 1980's, the WDFW estimated that Washington contained approximately 12,579 km^2 (4,857 mi^2) of lynx habitat which could theoretically support up to 238 lynx (based on a lynx

density of 2.5 lynx/100 km^2) (Koehler 2008, p. 1518; Stinson 2001, p. 16). However, based on professional opinions of individuals knowledgeable about lynx and lynx habitat, the WDFW adjusted this number down suggesting that Washington likely supported fewer than 100 individual lynx (Stinson 2001, p. 16). More recently, Koehler *et al.* (2008, p. 1523), estimated there was approximately 3,800 km^2 (1,467 mi^2) of lynx habitat in Washington potentially supporting up to 87 lynx. This more recent population estimate was based on a study investigating lynx habitat use in the Okanogan from 2002 to 2004, and used a lynx density estimate of 2.3 lynx/100 km^2 derived from a radio-telemetry study conducted on lynx in the Cascades from 1985-1987 (Koehler 1990, pp. 845-847). However, the study area in which the 2.3 lynx/100 km^2 density estimate reported by Koehler (1990, p.847) was derived is located in an area of the northern Cascades known as the "Meadows". During the time of Koehler's (1990, entire) study the Meadows provided some of the best lynx habitat in Washington, whereas most other lynx habitat in Washington is lower in elevation and more highly fragmented (Walker 2005, pp. 3, 6). Thus, the lynx densities Koehler observed in his study area in the Meadows may not translate to lynx densities throughout the rest of lynx habitat in Washington, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines. Thus, applying Koehler's estimated lynx density uniformly throughout Washington, may overestimate the overall lynx population capable of being supported in Washington.

Relative to the Okanogan LMZ (i.e., the north Cascades), which supports the only known persistent breeding population of lynx in Washington State, in 2001, the WDFW estimated the LMZ could support a maximum of 149 lynx (Stinson 2001, p. 16). This number was derived by estimating that the LMZ contains approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (which was decreased by 33 percent to account for unsuitable areas) combined with an average lynx population density estimate of 2.5 lynx/100km^2 derived from two studies conducted in the 1980s (Stinson 2001, p. 16). The estimated quantity of lynx habitat was based on mapping areas supporting the forest-type and physiographic characteristics identified as being used by lynx during telemetry studies conducted in the 1980s (Koehler *et al.* 2008, p. 1518), irrespective of the current condition (successional stage, or stand type, structure, or age, etc.) of the habitat. The estimation of lynx habitat was based purely on forested areas potentially supporting a forest-type potential of subalpine fir/Engelmann spruce, and the physiographic characteristics of elevations greater than 1,400 m (4593 ft) on mild to moderate slopes (Koehler *et al.* 2008, p. 1518), and did not consider whether the area was recently burned, harvested, etc. Recognizing that new information on lynx and snowshoe hare habitat use patterns had been learned since the 1980's, and that several large, stand-replacing fires had burned in lynx habitat, Koehler *et al.* (2008, entire) conducted a lynx telemetry study in the Okanogan from 2002 to 2004 to reassess the suitability of lynx habitat. They estimated that the Cascades contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on mapping areas supporting Engelmann spruce/subalpine fir forests with moderate canopy cover on flat to moderate slopes at elevations from 1,525 m (5003 ft) to 1,829 m (6000 ft) (Koehler *et al.* 2008, pp. 1521-1522). Therefore, at that time and using Koehler's (1990, p. 847) lynx density estimate of 2.3 lynx/100 km^2, the Cascades could theoretically support approximately 55 individual lynx.

From 1985 to 1987, the movements of five adult male and two adult female radio-collared lynx were monitored by Koehler (1990, entire) in the Cascades of north-central Washington. During the study two kittens were also captured and ear-tagged (Koehler 1990, p. 847). Results of the study indicated female average home range size was 39 km^2 (15 mi^2) and average male home range size was 69 km^2 (27 mi^2). Based on occupancy of the 640 km^2 study area by 15 adult lynx, adult lynx density was estimated to be 2.3 adults/100 km^2. Annual adult survival rates of the radio-collared lynx were 0.73 in 1986 and 1.00 in 1987, and kitten mortality was high at 88 percent with only 1 of 8 known kittens surviving its first year (Koehler 1990, p. 847).

As stated previously, fire is a common disturbance factor in boreal forests (Agee 2000, p. 47). Fire return intervals within western subalpine fir forests in the Cascades range from 109 to 250 years (Agee, 2000, p. 50) with typically high fire intensities in lynx habitat resulting in extensive areas of regenerating forest (Agee, 2000, p. 53). Maletzke assessed the effects of recent fires in the Cascades and their potential impacts to the lynx population there as follows:

> "From 1990-2002, there were about 2,600 km^2 of lynx habitat in the Okanogan (Eastern Cascades) area, and female home ranges were estimated at 39 – 41 km^2, suggesting the potential to support roughly 90-115 resident females (home ranges include "matrix" or non-habitat). By 2014, habitat had been reduced by fire to about 1,600 km^2, and habitat loss and fragmentation resulted in female home ranges increasing to an estimated 91 km^2, with a potential to support roughly 27 resident females" (Lynx Workshop Report 2016, p. 21).

Therefore, using Maletzke's method and assuming a 2:1 sex ratio of females to males, the total theoretical lynx population that may have been supported in the Cascades prior to 2002 may have ranged between 135 and 172 individual lynx. Subsequent to the fires the total theoretical lynx population potentially supported in the Cascades has been reduced to approximately 40 individual lynx, which potentially represents a 70 percent to 77 percent decline in the lynx population. Note: while the area (lynx habitat in the Cascade range) used to generate the population estimate of 55 lynx in the Cascades prior to the fires based on Koehler's (1990, p. 847) lynx density estimate is the same as the area used by Maletzke to generate his population estimate of 90 – 115 resident females based on simulated female home ranges with an empirically derived size and arbitrary minimum threshold of habitat, the two dissimilar population estimates used differing methodologies, and thus the population estimates themselves are not comparable. However, using Koehler's lynx density estimate of 2.3 lynx/100 km^2 and applying it to the 1,600 km^2 of lynx habitat remaining after the fires results in an estimated lynx population of approximately 37 individual lynx, which represents an approximate 33 percent reduction in the lynx population. Further informing the effects of these recent fires in the Cascades on lynx habitat is illustrated by evaluating the average size of a female lynx home range prior to and after the fires. Prior to the fires, Koehler (1990, p. 847) estimated an average female lynx home range size of 39 km^2 (15 mi^2), whereas after the fires Maletzke estimated the average female home range size had increased to 91 km^2 (35 mi^2) (Lynx Workshop Report 2016, p. 21). The important point is the recent large, stand replacing fires in the Cascades has resulted in significant temporary losses of lynx habitat, and thus the ability of the Cascades to support a persistent and viable reproducing lynx population may have been significantly impacted. The

areas impacted by these recent fires are expected to regenerate into suitable lynx habitat, but it may take 35-40 years to do so (Lynx Workshop Report 2016, p. 21).

Factors Affecting Current Condition: In 1993, lynx were classified by the Washington Fish and Wildlife Commission as a state threatened species (Stinson 2001, p. 22). On July 12, 2016, the WDFW recommended that the Washington Fish and Wildlife Commission uplist the lynx from a state threatened to a state endangered species (WDFW 2016, p.1). According to the Draft Washington State Periodic Status Review for the Lynx, the WDFW recommended listing the lynx as endangered due to: 1) observed range contraction in Washington following protection efforts; 2) the substantial loss of habitat in the last 20 years; and 3) the ongoing and anticipated threats to lynx population persistence.

Within Washington, the vast majority of lynx habitat is administered by the Okanogan/Wenatchee (OWNF) and Colville (CNF) National Forests. The North Cascades (aka the Okanogan LMZ in north-central Washington), which supports the only known, long-term persistent lynx breeding population in Washington, and within which critical habitat was designated for lynx in 2014 (79 FR 54782), is administered by the OWNF. Subsequent to listing lynx under the ESA, the Forest Service entered into a Conservation Agreement (CA) with the Service in 2000 (USFS and USFWS 2000, entire), which was revised and extended in 2006 (USFS and USFWS 2006, entire). The CA committed the ONWF and CNF to use the Lynx Conservation Assessment and Strategy (LCAS) for management of lynx and its habitat on their ownerships, and will remain in place until the forests amend or revise their individual LRMPs.

The LCAS, which was also developed pursuant to the listing by an interagency team comprised of USFS, BLM, Service, and NPS personnel, identified four primary risk factors potentially exerting population level effects upon the status of lynx: climate change, vegetation management, wildland fire management, and habitat fragmentation. To promote conservation of lynx and its habitat, the LCAS contains conservation measures addressing the identification and maintenance of lynx habitat (foraging, denning, and connectivity habitats) on federal lands. Toward this end, the LCAS recommends that federal land managers identify and map lynx habitat on their ownerships, and delineate LAUs containing the mapped lynx habitat, within which the effects of management actions on lynx habitat will be monitored and analyzed. The LCAS also recommends that the size of LAUs should be based on the average size of a female lynx home range and contain year-round habitat components (i.e., foraging and denning habitat). Thus, in Washington, and the north Cascades specifically, it appears that the single threat for which lynx were listed under the ESA (i.e., inadequacy of regulatory mechanisms) has largely been addressed through the development of the LCAS, and CA between the Forest Service and Service which commits the Forest Service, specifically for Washington the OWNF and CNF, to use the LCAS in the management of lynx habitat on their ownerships and when designing and implementing projects within LAUs.

The WADNR manages approximately 4 percent of the lynx habitat within portions of each of the delineated LMZs (WADNR 2006, p.9) in Washington State, including the Loomis State Forest that is located in the north Cascades of north-central Washington within the Okanogan LMZ. In

1996, the WADNR developed and implemented a Lynx Habitat Management Plan (1996 Lynx Plan) in response to listing of the lynx as a state threatened species by Washington State (WADNR 1996, entire). Subsequent to federally listing the lynx as threatened under the ESA, in 2006 the WADNR implemented a modified Lynx Habitat Management Plan (2006 Lynx Plan) incorporating new science into its 1996 Lynx Plan pertaining to lynx management (WADNR 2006, entire). Among other things, the WADNR 2006 Lynx Plan contains management standards and guidelines to avoid the incidental taking (as defined by the ESA) of lynx. These standards and guidelines address maintenance of lynx denning and foraging habitat, as well as habitat connectivity within and between LAUs and lynx populations within Washington (i.e., LMZs) and Canada.

For example, the WADNR 2006 Lynx Plan includes, among other things: (1) Encouraging genetic integrity at the species level by preventing bottlenecks between British Columbia and Washington by limiting size and shape of temporary non-habitat along the border and maintaining major routes of dispersal between British Columbia and Washington; (2) Maintaining connectivity between subpopulations by maintaining dispersal routes between and within zones and arranging timber harvest activities that result in temporary non-habitat patches among watersheds so that connectivity is maintained within each zone; (3) Maintaining the integrity of requisite habitat types within individual home ranges by maintaining connectivity between and integrity within home ranges used by individuals and/or family groups; and (4) Providing a diversity of successional stages within each LAU and connecting denning sites and foraging sites with forested cover without isolating them with open areas by prolonging the persistence of snowshoe hare habitat and retaining coarse woody debris for denning sites. The 2006 Lynx Plan also describes how WADNR will monitor and evaluate the implementation and effectiveness of the plan. The WADNR has been managing for lynx for almost two decades, and the Service has concluded that the management strategies implemented are effective. In the final revised critical habitat designation, published in the Federal Register on February 25, 2009 (74 FR 8657–8658), we determined that the benefits of excluding lands managed in accordance with the WADNR 2006 Lynx Plan outweighed the benefits of including them in the designation, and that doing so would not result in extinction of the species. We, therefore, again are considering excluding 164.2 mi^2 of lands managed in accordance with the WADNR 2006 Lynx Plan from the revised lynx critical habitat designation.

Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within the north Cascades (Koehler *et al.* 2008, p. 1523), which has significantly affected the status of and current viability of the lynx population within this geographic unit. As discussed below under *Potential Threats/Stressors/Factors Influencing Viability*, there is significant risk of potential future wildfires to further affect the viability of lynx in this geographic unit. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943), and as discussed below, climate change may similarly affect the future viability of lynx within this geographic unit.

4.2.5 Unit 5 - Greater Yellowstone Area

Unit Description: This geographic unit includes the parts of southwestern Montana and northwestern Wyoming the Service designated as critical habitat (Unit 5) for lynx in 2014 (79 FR 54825-54826). It encompasses approximately 23,691 km^2 (9,147 mi^2) in portions of Carbon, Gallatin, Park, Stillwater, and Sweetgrass Counties in Montana; and Fremont, Lincoln, Park, Sublette, and Teton Counties in Wyoming, with ownership that is 97.5 percent federal (USFS, NPS, and BLM); 2.2 percent private; and 0.3 percent State. This unit includes parts of Grand Teton and Yellowstone national parks and the Bridger-Teton, Custer-Gallatin, and Shoshone national forests, and lands managed by the BLM's Kemmerer and Pinedale Districts. It includes parts of the Absaroka, Beartooth, Gallatin, Gros Ventre, Salt River, Teton, Wind River, and Wyoming mountain ranges. This unit is not directly connected to lynx habitats and populations in Canada or to other DPS populations, although lynx dispersing from the north likely arrived intermittently into the area historically and, more recently, some lynx released into Colorado traveled into and through this unit (see Devineau *et al.* 2010, p. 526). Relative to other DPS lynx populations, this unit is about 145 km (90 mi) southeast of the Northwestern Montana/Northeastern Idaho unit, and roughly 400 km (250 mi) northwest of the Western Colorado geographic unit.

Habitat Description: In northwestern Wyoming and the GYA, lynx are generally associated with Englemann spruce-subalpine fir and lodgepole pine of the Rocky Mountain Conifer Forest vegetation class, as described above (Section 4.1.3) for the northwestern Montana, although this habitat and, thus, lynx typically occur at higher elevations (2,000-3,000 m [6,550-9,850 ft]) in the GYA (McKelvey *et al.* 2000a, p. 245; ILBT 2013, p. 60). Potential lynx habitat in much of the GYA is naturally marginal (patchier and composed in many places of drier forest types), with fewer shrubs and a more open understory, and generally low to marginal hare densities, resulting in a spatially-limited distribution of lynx with large home ranges (Squires *et al.* 2003, pp. 5, 12-13; 68 FR 40090; 71 FR 66010, 66029; 74 FR 8624, 8643–8644; Hodges *et al.* 2009, entire; Berg and Gese 2010, p. 1750; 79 FR 54796; Lynx SSA Team 2016, p. 45). Among the three national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 42 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123).

In Yellowstone National Park, 7,732 km^2 (2,985 mi^2; about 86 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 2,784 km^2 (1,075 mi^2; 31 percent of the park, 36 percent of lynx forest types) is estimated to be potential lynx habitat (68 FR 40086). However, hares were completely absent from more than 36 percent of surveyed stands in Yellowstone National Park, and 96 percent had estimated hare densities below the 0.5 hare/ha threshold thought necessary to support resident lynx (Hodges *et al.* 2009, 870, 873-877). In contrast, estimated hare densities were >= 0.48 hares/ha in all surveyed stands on the Bridger-Teton National Forest in the southern portion of the GYA, with highest densities (1.7 hares/ha) in 30-70-year-old regenerating lodgepole pine stands with dense horizontal cover, and densities of 1.2 - 1.6 hares/ha in mature multi-storied spruce-fir and mixed spruce-fir (containing aspen or lodgepole pine) stands (Berg *et al.* 2012, p. 1483). In the central Wyoming Range in the southern part of this unit, hare tracks were more abundant in seral aspen stands with a

significant spruce-subalpine fir component than in aspen stands with little or no spruce-fir, and hares appeared to be absent from pure aspen stands except where they bordered spruce/fir areas (Endeavor Wildlife Research 2009, p. 4). The only lynx den sites described for this unit (the natal den and a subsequent maternal den of one female in 1998) occurred in a mature subalpine fir-lodgepole pine forest in the Wyoming Range, where coarse woody debris and high sapling density provided dense horizontal cover (Squires and Laurion 2000, pp. 346-347).

Average annual snowfall in this unit ranges from about 127 cm (50 in) in Bozeman and 556 cm (219 in) in West Yellowstone, Montana, on the northern and northwestern peripheries of the unit, respectively, to 280-310 cm (110-122 in) in Alpine, Dubois, and Jackson, WY near the central and southern peripheries, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 8/17/2016). In potential lynx habitats on the Bridger-Teton National Forest in the southern half of this unit, deep snow persisted from late October through May (Berg *et al.* 2012, p. 1481).

Habitat Status: Potential lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 97 percent (23,109 km^2 [8,922 mi^2]) of this unit is in federal ownership, including 18,877 km^2 (7,292 mi^2) in national forests under USFS management, 3,944 km^2 (1,523 mi^2) in national parks managed by NPS, and 271 km^2 (105 mi^2) managed by BLM. As described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2008 and 2010 revised its RMPs for the Pinedale and Kemmerer districts, respectively, to include conservation measures and BMPs for lynx based on the LCAS (BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). On lands with developmental land-use allocations, these amended forest plans and the revised BLM RMPs provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has l kely benefitted lynx by providing a consistently-applied framework for conserving and restoring important hare and lynx habitats.

As elsewhere in the DPS (Squires *et al*. 2010, p. 1656; ILBT 2013, pp. 20, 27), winter foraging habitat is likely the most limiting habitat for lynx in this unit, and denning habitat is not thought to be limiting. Standards, guidelines and BMPs in the NRLMD and in revised BLM plans restrict vegetation management activities that could reduce winter snowshoe hare habitat and direct the creation or retention of coarse woody debris in areas where denning habitat may be lacking (USFS 2007, Attachment 1, pp. 2-5; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America,

showing that most of this geographic unit has a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

This unit includes substantial areas in nondevelopmental land-use allocations, including (in addition to Yellowstone and Grand Teton national parks) the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie designated wilderness areas. Among the three national forests that contribute to this unit, 75 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34). Management activities in these areas are unlikely to adversely impact lynx and hare habitats.

Large parts of Yellowstone National Park burned in the extensive wildfires of 1988. Although the extent to which those fires may have impacted potential lynx habitats is uncertain, some of the burned areas may soon reach a stage of regeneration capable of supporting increased densities of hares, perhaps increasing the likelihood that lynx could reestablish and maintain home ranges in some parts of the park (Lynx SSA Team 2016, p. 45).

Because non-federal lands make up less than 3 percent of lynx habitats in this unit, it is unlikely that activities on those lands have impacted lynx populations or meaningfully influenced the unit's current capacity to support resident lynx.

Overall, although naturally fragmented and patchily-distributed, potential lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway, railroad) development, past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

In summary, much of this geographic unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental land-use allocations, where management activities with the potential to adversely affect lynx habitat generally do not occur. Almost all lands with developmental land-use allocations in this unit are managed by the USFS to conserve and maintain lynx and hare habitats under management plans that were formally revised in 2007 in accordance with the NRLMD and based on the scientific findings and conservation recommendations of the LCAS. A small proportion of lands with developmental allocations occurs on BLM lands where management plans also were revised recently (2008 and 2010) to adopt conservation measures identified in the LCAS. Implementation of these USFS and BLM plans likely precludes landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places. Additionally, because lynx habitats in this unit are naturally highly-fragmented and, in most places, support low landscape-level hare densities, relatively minor impacts, especially to hare and lynx winter foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit. As described in section 2.3.2.2 above, the historic record and recent research show that the GYA has supported resident lynx, but it is unclear whether the area consistently supported a persistent resident population over time or whether it naturally supported resident lynx only intermittently. Most historic and recent verified lynx records are from the southern portion of this unit in the Gros Ventre, Salt River, Wind River, and Wyoming mountain ranges in the Bridger-Teton National Forest. Eighteen lynx were reported to have been trapped from a small area in the Wyoming Range in 1971-72 (Squires and Laurion 2000, p. 338), but it is unknown whether any of those lynx were residents (and if so, how many) or if some or all of them were dispersers associated with the "explosion" (irruption) of lynx documented in several places in the contiguous U.S. in the early 1970s (McKelvey *et al.* 2000, pp. 235-242). However, two resident lynx, a male and a female, were trapped, radio-marked, and monitored in the Wyoming Range over several years beginning in 1996. The female produced four kittens in 1998 and two in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000 (Squires and Laurion 2000, p. 346; Squires *et al.* 2001, pp. 9, 26). The female's home range averaged 50 km^2 (19 mi^2) over the 3 years she was monitored, and the male's averaged 824 km^2 (318 mi^2) over five years (Squires *et al.* 2003, pp. 12-13). The male also made multiple long-distance exploratory movements (up to 728 km [452 m], including multiple highway crossings) over 3 successive years (Squires *et al.* 2003, pp. 13-16; Squires and Oakleaf 2005, entire).

Other surveys also detected lynx in the southern portion of this unit from 1999-2009, with records most consistent in the Wyoming Range, Togwotee Pass, Union Pass, the Bondurant Corridor, and in the Gros Ventre Range (Squires *et al.* 2001, pp. 9-14; Squires *et al.* 2003, pp. 9-11, 29-31; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Squires *in* Lynx SSA Team 2016, pp. 20-21). Additionally, 10 radio-marked lynx released in Colorado subsequently moved into or through this portion of the GYA unit from 2004-2010, with locations concentrated in areas used previously by native Wyoming lynx (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.). Several of the Colorado-released lynx occupied home ranges (including overlapping male and female home ranges) in areas of the Wyoming Range previously occupied by "native" resident lynx (Squires *in* Lynx SSA Team 2016, p. 21), but there is no evidence of reproduction among these lynx. On the Shoshone National Forest in the northeastern part of this unit, seven lynx snow tracks were confirmed by DNA analysis in winter 2005/06, and a single track was verified the following winter (Endeavor Wildlife Research 2008, p. 2; Berg 2016, pers. comm.). During the winters of 2004-05 through 2007-08, 26 snow tracks on the Bridger-Teton and Shoshone national forests were confirmed by DNA analyses to be from five individual lynx (3 males, 2 females). One of the males had previously been documented in Yellowstone National Park (see below). The other two males and both females were lynx that had been released in Colorado (Pilgrim 2016, pers. comm.).

Verified records of lynx are less common elsewhere in this unit, including in Yellowstone and Grand Teton national parks and the Custer-Gallatin National Forest. There were no verified records of lynx in Yellowstone National Park from 1920-1999 (McKelvey *et al.* 2000, p. 230); however, surveys in 2001-2004 documented at least 3 individual lynx, including two kittens, in

the eastern part of the park (Murphy *et al.* 2006, entire). Several Colorado-released lynx also traveled through the park (Devineau *et al.* 2010, p. 526), and two possible (unconfirmed) lynx tracks were recorded in the park during winter 2008/2009 (Endeavor Wildlife Research 2009, pp. 4, 12). On the Custer-Gallatin National Forest in Montana in the northern part of the unit, a single female was detected over six consecutive winters (2003/2004 - 2008/2009) but not subsequently (Gehman *et al.* 2010, pp. 2-4), and it appears that she did not encounter a male or produce kittens during the six years she was detected (Gehman *et al.* 2010, p. 4).

Recent surveys and research-related trapping efforts have failed to detect lynx in this unit after 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45; Hanvey 2016, pers. comm.). As discussed above and in section 2.3.2.2, it is uncertain whether this unit historically supported a small but persistent resident population that was recently extirpated, or if it historically and recently has supported resident lynx only intermittently. Given the protected conservation status of millions of acres in this unit, its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx (Lynx SSA Team 2016, p. 57). Conversely, the characteristics described above suggest that relatively small impacts could tip this unit from just barely able to support a persistent resident population to incapable of doing so. Further, the available evidence suggests that if this unit did support a persistent population, it was very likely a very small one, which would be more vulnerable to extirpation due to demographic, environmental, and genetic stochasticity, and to catastrophic events (McKelvey *et al.* 2000b, pp. 23-29), or to a combination of these factors.

Factors Affecting Current Conditions: *Regulatory Mechanisms* - As described above for Unit 3, federal management activities (e.g., timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level to threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distr bution of lynx habitats in some parts of this unit. Current regulatory mechanisms and conservation measures associated with recently amended or revised federal management plans are intended to conserve and restore lynx and hare habitats across large landscapes. Although their effectiveness has not been quantitatively evaluated, they have almost certainly reduced significantly the potential for adverse management-related impacts to lynx habitats in this unit.

Lynx trapping has been prohibited in Wyoming since 1973 (79 FR 54794) and in Montana since 1999 (MTFWP 2016, p. 7) and, as described in section 3.1.2, above, both states require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, no lynx are documented to have been incidentally trapped in the Montana portion of this unit (MTFWP 2016, pp. 5-10) and we are aware of no incidental captures in northwestern Wyoming since listing.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Mote *et al.* 2005, entire; Pederson *et al.* 2013; Riley *et al.* 2013; Dennison *et al.* 2014, entire; USEPA 2015, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities low in some places, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609).

Vegetation Management - The influence of vegetation management on the current condition of lynx and habitats in this unit is described above under Habitat Status and *Regulatory Mechanisms*.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, likely in response to climate warming and related increases in drought conditions (e.g., Dennison *et al.* 2014, entire; Harvey *et al.* 2016, entire; Westerling 2016, entire), with most large, stand-replacing fires having occurred in the northern part of the unit, in Yellowstone National Park (see Harvey *et al.* 2016, Fig. 1). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to continue to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction on lands with

developmental allocations. Much of this unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental allocations. Even in areas with developmental allocations, the moist subalpine forests important to lynx have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx. Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Wyoming (1; a Colorado-released lynx) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates of are unknown. Although this unit is not directly connected to lynx habitats and populations in Canada or elsewhere in the contiguous U.S., no barriers to lynx dispersal from the north have been identified, and 10 lynx released in Colorado are known to have dispersed northward into and through this unit (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.), demonstrating that dispersal between the southern and northern Rockies is poss ble. As described above in Lynx Status, the large number of lynx reportedly trapped from a small area of the Wyoming Range in the early 1970s (Squires and Laurion 2000, p. 338) may suggest dispersers associated with the irruption of many lynx from Canada into the northern contiguous U.S. documented at that time (McKelvey *et al.* 2000, pp. 235-242). No subsequent pulses of lynx dispersing from the north have been documented, and lynx trapping records suggest that the magnitude of lynx populations cycles in Alberta and British Columbia, the most likely source of lynx dispersing southward into this unit, dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

As described in section 3.2, above, a number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this geographic unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, it is possible that it has contributed to the recent apparent loss of resident lynx from this unit.

4.2.6 Unit 6 - Southern Rockies Geographic Area

Unit Description - The overall geographic unit includes Colorado, south-central Wyoming, and north-central New Mexico. However, within the southern Rockies, since we currently have no evidence of resident lynx in southern Wyoming or northern New Mexico, and we question the ability of these two areas to support breeding populations we are not including these two areas in the unit description. Lynx habitat in Colorado totals approximately 25,294 km^2 (9,766 mi^2), and is distributed west of US Interstate-25. We excluded the northwest part of the state bounded on the south by US Interstate-70 and the east by Colorado State Highway 13, because this area lacks sufficient habitat to support lynx. Lynx habitat in Colorado falls within the following land ownerships, USFS 21,555 km^2 (8,322 mi^2), BLM 772 km^2, (298 mi^2), NPS 452 km^2 (174 mi^2), Private 2,350 km^2 (907 mi^2), State 164 km^2 (63 mi^2).

The southern Rockies are separated from the rest of the Rocky Mountain chain, and thus lynx habitat in northern and western Wyoming, by sagebrush and desert shrub communities in the Wyoming Basin and the Red Desert of southern and central Wyoming, and the arid Green and Colorado River plateaus of western Colorado and eastern Utah. Connectivity of lynx habitat has been identified as an important consideration for the southern Rockies, because of the extreme topographic relief juxtaposed with human developments such as highways and residential communities.

Habitat Description - Lynx habitat in the southern Rockies is found within the subalpine and upper montane forest zones, generally above 2,900 m (9,514 ft) elevation (Shenk 2009 page 10). In the upper elevations of the subalpine zone, forests are typically dominated by subalpine fir and Engelmann spruce. As the subalpine zone transitions to the upper montane, spruce-fir forests begin to give way to lodgepole pine and aspen. On cooler, mesic mid-elevation sites, Engelmann spruce may retain dominance, intermixed with aspen, lodgepole pine, and Douglas-fir. Lodgepole pine reaches its southern limits in the central part of the geographic unit, while southwestern white fir occurs only in the San Juan Mountains. The lower montane zone is dominated by ponderosa pine and Douglas-fir, with pines typically dominating on lower, drier, more exposed sites, and Douglas-fir occurring on the more sheltered sites. Lower montane forests do not support snowshoe hares and seldom would be used by lynx.

Mature Engelmann spruce/subalpine fir forests with total canopy cover of 42–65 percent, of which 15–20 percent was contr buted by conifer understory tree canopies, were the most commonly used areas, followed by mixed forests of Engelmann spruce/subalpine fir/aspen (Shenk 2008, page 15). Riparian and riparian-mix was the third most-used cover type, with a pattern of increasing use beginning in July, peaking in November, and dropping off in December. Large or medium willow/alder carrs and willow riparian communities provided important habitat for snowshoe hare, grouse, ptarmigan (winter), and other prey species that could be utilized by lynx.

Ivan *et al.* (2012 page 5) confirmed some relationships that were already known (e.g., lynx are strongly associated with high-elevation spruce/fir and mixed spruce/fir forests but avoid lower-

elevation montane forests and montane shrublands). We recognize that all spruce-fir forest does not support lynx equally based on the low detection rate (28 percent) reported during the ongoing lynx study in the San Juan Mountains within predominantly spruce-fir forest (Ivan, Workshop presentation 2015, p. 14), thus not all areas of spruce-fir forest are used by lynx.

Dolbeer and Clark (1975 page 539) estimated a density of 0.73 hares/ha (0.3 hares/ac) within their study site in Colorado, with the highest densities of snowshoe hare in mature and late-successional spruce-fir forests. However, this study was conducted in a very limited area and did not sample younger sapling-stage stands (15-40 years post-disturbance) to compare hare densities with those reported for mature and late-successional spruce-fir forests (USFWS 2008, p. 32).

Habitat that supports snowshoe hares is patchily distr buted in the Southern Rocky Mountains Geographic Unit, which limits their abundance. Zahratka and Shenk (2008 entire) found densities of snowshoe hares to be greatest in mature Engelmann spruce-subalpine fir stands when compared to mature lodgepole pine stands in Taylor Park, Colorado. Their density estimates were 0.08±0.03 to 1.32±0.15 hares/ha (0.03–0.5 hares/ac) in Engelmann spruce-subalpine fir habitats, and 0.06±0.01 to 0.34±0.06 hares/ha (0.02–0.14 hares/ac) in lodgepole pine habitats (Zahratka and Shenk 2008 entire).

Ivan (2011*a in ILBT 2013*) compared snowshoe hare density, survival, and recruitment in mature uneven-aged spruce/fir stands, small-diameter lodgepole pine (2.54–12.7 cm [1–5 in]) stands (20–25 years old), and medium-diameter (12.7–22.9 cm [5–9 in]) previously-thinned lodgepole pine stands (40–60 years old) in Colorado. During summer, Ivan (2011*a* in *ILBT 2013*) recorded densities of 0.2+0.01 to 0.66+0.07 hares/ha (0.08–0.27 hares/ac) in small lodgepole pine forest, 0.01+0.04 to 0.03+0.03 hares/ha (0.004–0.01 hares/ac) in medium lodgepole forest, and 0.01±0.002 to 0.26±0.08 hares/ha (0.004–0.1 hares/ac) in spruce/fir forest; densities were more similar across the 3 forest types during the winter months. He concluded that “hares reached their highest densities and recruited juveniles most consistently in stands of small lodgepole, followed closely by spruce/fir, but survival was highest in spruce/fir stands.”

Habitat Status - At the time of the 2000 listing, we identified 26,305 km^2 (10,156 mi^2) of potential lynx habitat in the Southern Rockies (i.e., Colorado and southern Wyoming) [65 FR 16052). In 2003, we estimated 31,027 km^2 (12,419 mi^2) of potential habitat within the southern Rockies (68 FR 40076). As stated above, our focus here is limited to the state of Colorado. In 2008, the USFS reported that most of their LAUs in the southern Rockies fell within a range of 3-8 percent in a currently unsuitable condition, with only one LAU exceeding 30 percent unsuitable (USFS 2008, p. 19). Currently, the USFS reports 51 out of 202 (25%) LAUs currently exceed the 30 percent unsuitable condition (P. McDonald 2016, pers. comm.). These changes are mostly in response to the ongoing bark beetle infestations, as well as wildfire events that have occurred since 2008.

Ivan *et al.* (2012, p. 6), developed a predictive map of lynx habitat use by using lynx location data collected during CPWs reintroduction monitoring, then estimated the amount of habitat associated with a high probability of detecting lynx. Our review of the vegetative characteristics of CPW's predictive map detected large areas of spruce-fir habitats that were excluded by their presentation of the habitat associated the top 20 percent of predicted use. Therefore, we selected the top 30 percent of the Ivan *et al.* (2012, entire) predictions and the associated habitat to represent the amount of potential lynx habitat in Colorado totaling 25,294 km^2 (9,766 mi^2). This habitat estimate falls between the Ivan *et al.* (2012, p. 6) estimate and the USFS's habitat estimate of 30,664 km^2 [11,839 mi^2] (USFS 2008, p. 18), while retaining a greater than 60 percent probability of detecting lynx as described by Ivan *et al.* (2012).

Regulatory mechanisms in Colorado are largely provided through Forest Service planning documents. All USFS land management plans within the unit were amended in 2008 to provide for the conservation of lynx. Three BLM plans in Colorado have been amended or revised to conserve lynx following the 2013 LCAS, totaling approximately 126 km^2 (49 mi^2). One additional plan provides conservation measures for timber management actions only, but the FO contains only about 1 km^2 (0.39 mi^2). The remaining FOs currently have not amended or revised their plans specifically to provide conservation for lynx (approximately 645 km^2 (298 mi^2), Since the 2000 listing however, all BLM Field Offices in Colorado have been conserving lynx discretionarily through application of conservation measures provided in the Lynx Conservation Assessment and Strategy (Ruediger *et al.* 2000, entire; ILBT 2013, entire). Rocky Mountain National Park has a fire management plan that includes conservation measures for lynx. We are not aware of any specific conservation planning guiding activities on non-federal lands (M. Wrigley 2016, pers. comm. ; M.K. Watry 2016, pers. comm.).

Lynx Status - As of 2016, the current distribution of lynx is somewhat uncertain within Colorado. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell 2016, undocumented pers. comm.), and Rocky Mountain National Park (Shenk 2008, p. 3). The CPW is developing a minimally-invasive, long-term, statewide monitoring program to track the distribution, stability, and persistence of lynx in Colorado (Ivan 2012, entire).

As of 2015, evidence of recent lynx reproduction is provided through kittens captured on game cameras accompanying adult females at three locations during 2014-2015 monitoring effort (Ivan presentation 2015 page 17). In addition 38 percent of lynx captured during recent (2010-2015) USFS Rocky Mountain Research Station research projects in Colorado have been young and/or unmarked cats (Ivan *in* Lynx SSA Team 2016, p. 17), suggesting continued reproduction within Colorado. However, reproductive rates are currently unknown.

As of 2007, the average probability of survival for reintroduced lynx was 0.9315±0.0325 within the study area in the San Juan Mountains and 0.8219±0.0744 outside the study area boundary (Devineau *et al.* 2010, page 5). Although 30 percent of known mortalities were due to human causes (being shot or hit by a vehicle), the estimate of survival within the study area was higher than those reported for natural, lightly trapped populations of Canada lynx in the Yukon (0.75–

0.90; Slough and Mowat 1996 entire, O'Donoghue *et al.* 1997, page 155) or in the Northwest Territories (~0.90; Poole 1994, page 612). Successful reproduction, including by females born in Colorado, has been documented (Shenk 2008, page 2), and kitten survival was 0.2260 (Jake Ivan, pers comm. March 9, 2016).

Factors Affecting Current Conditions - Colorado is currently experiencing major bark beetle epidemics in lodgepole pine and spruce-fir forests. Although bark beetles are native insects, and forests in the western U.S. have experienced regular insect infestations throughout their history, the current bark beetle epidemic is notable for its intensity and extensive geographic range. The causes of this epidemic include: relatively even-aged, dense, and homogenous forest conditions, which are highly susceptible to beetle attack, and which were created by large-scale logging in the late 1800s and subsequent fire suppression efforts; warmer winters due to climate change (cold winters typically reduce beetle populations); and a multi-year drought that occurred in the mid-1990s through early 2000s, stressing the trees and making them more susceptible to beetle attack (USFS 2011, pp. 4).

In lodgepole pine forests, a mountain pine beetle (*Dendroctonus ponderosae*) epidemic typically kills the entire overstory and results in a stand-replacing disturbance event. In Colorado, more than 1,375,931 ha (3,400,000 ac) has been affected by mountain pine beetle, and 639,000 ha (1,579,000 acres) affected by spruce beetle since 1996 (USFS 2015, p. 3), a portion of which overlaps with lynx habitat.

Even-aged mature and "dry" lodgepole pine stands characteristically have depauperate understory vegetation and are not capable of supporting dense populations of snowshoe hares. On moist sites, regeneration of beetle-killed lodgepole pine stands is expected to be relatively rapid 20-30 years, and the new stands will be dominated by resprouting aspen or by a new cohort of lodgepole pine. If these newly-established stands grow tall and dense enough to provide horizontal cover above the snow layer, they may produce excellent habitat for snowshoe hares and lynx for several decades, until the crowns again lift above the reach of snowshoe hares.

A spruce beetle epidemic kills the larger-diameter trees and can also result in a stand-replacing disturbance event. Because of the importance of spruce-fir forests for production and survival of snowshoe hares (Ivan 2011a in ILBT 2013), widespread mortality of mature spruce/fir forests could impact lynx habitat for a long duration. By 2015, the spruce beetle outbreak influenced approximately 95 percent of the mature spruce component of the subalpine cover types on the Rio Grande National Forest (Squires *et al.* unpublished report 2016, page 1). Despite the large scale, and almost complete mortality of the mature spruce component within their study area, lynx continue to use and reproduce in the beetle-infested forests (Squires *et al.* unpublished report 2016, page 2). Since the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. However, habitat connectivity may be negatively affected by intense recreational use or development within strategic areas that are important for habitat connectivity.

ILBT (2013 p. 57; 61-62) states:

> *Plague, a flea-borne disease caused by the bacterium Yersinia pestis, which is not native to North America, was reported for the first time in lynx in Colorado (Wild et al. 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 reintroduced lynx between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to Y. pestis; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado.*
>
> *Vehicular collisions are a potentially important cause of mortality for lynx in portions of the southern Rockies. Thirteen of 102 mortalities documented for lynx translocated into Colorado were from vehicle collisions (Devineau et al. 2010). Brocke et al. (1990) suggested that translocated animals might be more vulnerable to highway mortality than resident lynx and this could have been a factor in Colorado at the time of listing. Currently, the majority of lynx mortalities caused by vehicle collision (13 of 16) occurred during the reintroduction period (1999-2006). Since early 2007, one year after the final reintroductions occurred, only 3 hit by vehicle mortalities have been reported, and only two of those occurred in Colorado (Broderdorp unpublished data 2016). A number of highways with high speed and high traffic volume pass through lynx habitat, such as I-70, I-80, US 50, US 550 and US 160. These highways are not a barrier to lynx movement, as repeated successful crossings by radio-telemetered lynx have been documented on I-70 and Highways 9, 40, 50, 91, and 114 (Ivan 2011b, c, 2012; J. Squires, personal communication 2012). At this time, it appears that hit by vehicle mortality may be a less significant mortality factor for lynx in Colorado.*
>
> *As compared with other portions of the range of lynx, in Colorado more winter recreation and associated development overlaps with lynx habitat. Preliminary information from a study in Colorado indicates that some winter recreation uses may be compatible, but lynx may avoid some developed ski areas (J. Squires, personal communication 2012). It is possible that ski areas and 4-season resorts may reduce the amount and availability of lynx habitat within localized areas, in part by influencing the distribution or abundance of prey resources within the developed area. However, there is also considerable anecdotal evidence of lynx using ski areas.*
>
> *Leg-hold trapping is currently prohibited under the state constitution of Colorado as a means of predator control or for commercial and recreational trapping. If a landowner can prove that all other non-lethal methods have been ineffective, a 30-day exemption may be granted for depredation cases. Incidental trapping mortality of lynx may be a minor risk during trapping seasons in southern Wyoming and surrounding states.*
>
> *Predator control activities on federal lands, including coyote shooting or trapping, are common throughout most of this geographic area, mostly related to the grazing of domestic sheep. The majority of sheep grazing occurs on arid rangelands, but some*

grazing does occur during summer at the higher elevations, especially in south-central Colorado. Incidental capture of lynx is possible, but unlikely.

Chapter 5: Future Conditions

In this chapter, we present our assessment, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the potential future status of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the likely future conditions in each geographic unit, followed by a more detailed evaluation of the factors likely to influence lynx populations and habitats in each unit. We present and summarize the professional judgments and opinions of a panel of 10 lynx experts regarding the factors likely to influence the persistence of resident lynx populations in the DPS as a whole and in each of the six geographic units. We also present and summarize the experts' projections, based on consideration of those influencing factors, of the probability that each of the geographic units will continue to support resident breeding populations of lynx into the future (at years 2025, 2050, and 2100). We then provide additional Service review of the influencing factors described in Chapter 3, above, and their potential effects on the ability of each geographic unit to support lynx populations in the future.

Commented [MJM30]: But this doesn't describe the full risk profile of the species. I'm more interested in future scenarios that indicate imperilment but are not necessarily likely.

5.1 Summary of Future Conditions DPS-wide

Given the irresolvable uncertainty about the historical distribution of resident lynx in the contiguous U.S. and the current lack of reliable estimates of the sizes, trends, and many demographic parameters for most DPS populations, it is difficult to confidently predict the future status of the DPS or the likelihood that any given geographic unit will support resident lynx in the future. We lack data to build rigorous empirical population models for lynx in the DPS, and uncertainty regarding the timing and magnitude of potential impacts to lynx from continued climate warming also limit our ability to predict future conditions for the DPS. Therefore, our assessment of the future of the DPS is based on the best professional judgments and opinions of lynx experts and our evaluation of the available scientific information regarding the factors identified by the ILBT as the most likely to have population-level impact to lynx in the DPS (ILBT 2013, pp. 68-78).

Overall, expert opinion and our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). This outcome seems likely regardless of which climate emissions scenario is used to model future conditions, although the timing, extent, and magnitude of impacts is uncertain and will likely vary by scenario.

In addition to climate change, forest management also has the potential to influence (negatively or positively) hare and lynx habitats in the DPS range. Forest management on private lands that lack lynx conservation commitments may contribute to future declines in the amount and quality of lynx habitats, particularly in Maine and perhaps also in Minnesota (private lands contribute minimally to lynx habitats in the other geographic units – see Table 1, above). Uncertain future forest ownership and markets for forest products, shifts in silvicultural practices, and development pressures on private lands all may affect the resiliency of future lynx populations and thus the units. The lack of evaluation of the effectiveness of forest management plans for lynx on federal lands is of concern for western units.

In each geographic unit, the probability that resident lynx populations will persist is expected to decline in the future, although uncertainty about persistence probability increases with time from the present (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below). Although all five geographic units that currently support resident populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century. All other geographic units have a 50 percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below), with a moderate to high likelihood that resident lynx will be lost from two to four units by then (Figure 7).

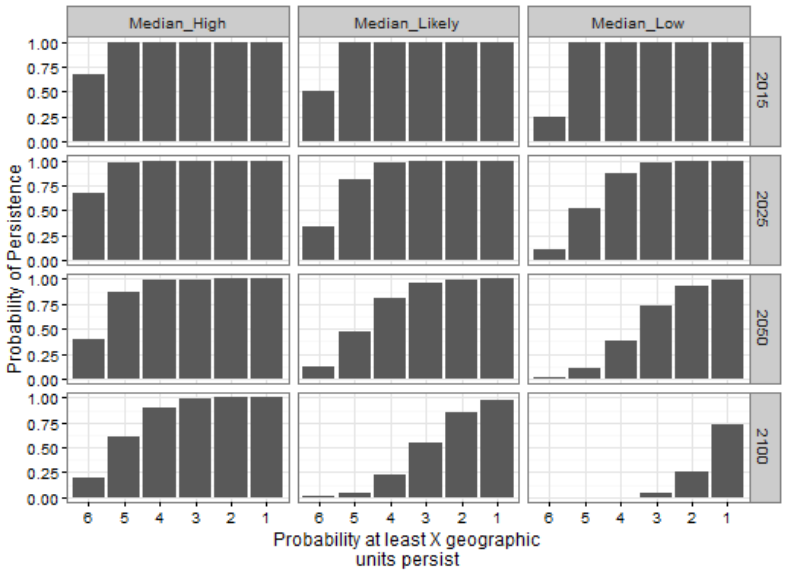


Figure 7. Summarized probability of persistence of at least a given number of geographic units given the probability of persistence for each individual geographic unit. The y axis of each grid in

Figure 7 is the probability that at least the number of geographic units indicated by the x axis of the grid persist. The probability in a bar reaches 1 when there is no probability of fewer geographic units persisting. Moving from top to bottom the grids show the probabilities by time period (2015, 2025, 2050, and 2100). Moving from left to right the grids show the range of expert responses by summary selection type and probability response. Therefore looking down a column of grids provides a view of the trend in persistence through time and looking across a row of grids provides a view of the range of uncertainty in persistence for a given time period.

The loss of resident lynx from one or more geographic units would represent reduced future redundancy, representation, and resiliency within the lynx DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (e.g., additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and l kely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Based on expert input, there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and l kely future relative genetic health of the DPS.

How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

In terms of resiliency, expert opinion and our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are l kely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are l kely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

5.1.1 Summaries of Future Conditions in Each Geographic l Unit

Unit 1 – Northern Maine: Although the Northern Maine geographic unit currently has extensive lynx habitat, it may be one of the units in the DPS at greater risk. Forestry practices and climate change will be the greatest future drivers of hare and lynx habitat. Lynx habitat and numbers are expected to decline by 50 to 60 percent by 2032 in response to aging of the budworm-era clearcuts and the effects of 27 years of extensive partial harvesting. In the next few decades, high quality hare habitat will drop from about 10 percent to 5 percent of the landscape. High quality habitat patches will become more fragmented, smaller, and more isolated, thus making the landscape less suitable for lynx. For the next few decades the best habitat will occur in the southern portion of the range where effects of climate change and competition with bobcats are l kely to be greatest. Absent long-term lynx management agreements, the future of lynx habitat is uncertain. Wood products markets will continue to change, and could be affected by interest in carbon sequestration in response to climate change. Rapid changes in private forest land ownership are likely to continue resulting in subdivision of large ownerships. Changing land uses (wind energy development, transmission line corridors, residential and development, national monument) will compete with forest management as the primary land use. Conservation easements will help reduce development pressures and keep some lands as working forest. Climate change is expected to affect the Maine unit more than others in the DPS because snow depth and duration already seem to be at thresholds for lynx and there are few potential elevational refugia. In the near term and to mid-century, snow quantity and quality will continue to deteriorate, likely causing the range of lynx to begin contracting northward. In the long term (to 2100), some believe lynx could become extirpated from the unit. Climate change, increasing demand for hardwood forest products, a pending spruce-budworm outbreak, and frequent disturbance of the forest all will contribute toward the trend in the loss of spruce-fir forest and expansion of northern hardwoods, although the timeframe for conversion is uncertain. Lynx experts indicate the probability of persistence will decline to about 50% by the end of the century. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, lack of elevational refugia), some members of the Service's SSA

team were more pessimistic about the future of lynx in Maine than the lynx expert panel. There is great uncertainty about the future of forest management and future development on private forest lands. There are no long-term management plans in place, State forest regulations have greatly influenced harvesting practices that have (and will continue to) reduce landscape hare densities, markets for forest products are depressed, and projections (under current harvest scenarios) are that habitat will diminish and shift southward in the near term because of post-harvest succession and recede northward over the longer-term because of continued climate warming.

Unit 2 - Northeastern Minnesota: The direct and indirect effects of climate change are expected to affect lynx into the future in Minnesota. Specifically, there is an expected decline in the quantity, quality, and duration of snow; increased competition and hybridization with bobcats; northward contraction of boreal conifer forest; and increased isolation due to diminishing forest conditions in Ontario. The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century, driven in the near term by the quality, quantity and persistence of snow, competition, disease, and forest insects, and over the long term from the some of the same reasons with the addition of climate change, loss of spruce-fir forests, and wildfires. If the SNF in Minnesota continues to follow vegetation management and other recommendations under the LCAS in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue on State and private lands. Taking all factors into consideration (i.e., loss of boreal forest, increased competition, potential disease and insect outbreaks, loss of snow), lynx experts projected the mean probability persistence of lynx in Minnesota to the year 2025 was greater than 90 percent, to 2050 was 80 percent, and would decline to approximately 35 percent by 2100.

Unit 3 - Northwestern Montana/Northeastern Idaho: As in other units, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Fire- and insect-related habitat losses would likely be temporary, resulting subsequently in improved habitat conditions when impacted areas regenerate the dense vegetative structure conducive to hare abundance. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Lynx experts felt that future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Considering the factors above, lynx experts felt this geographic unit has the highest likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence >

0.95), at mid-century (median = 0.90), and end-of-century (median = 0.78), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units.

Unit 4 - North-central Washington: Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within north Cascades, which has significantly affected the status of and current viability of the lynx population within this geographic unit. Similar to the other geographic units, climate change is anticipated to reduce the future quality and distr bution of lynx habitat in Washington, potentially further exacerbating the recent temporary losses of lynx habitat from wildfires. Climate change may increase wildfire frequency and severity, which may result in further temporary losses of lynx habitat. Climate change may also decrease the quantity and quality of snow resulting in permanent reductions in the quantity and distr bution of lynx habitat in Washington State. These potential climate change driven reductions of lynx habitat may serve to further isolate lynx populations within Washington State as well as between neighboring lynx populations in the other geographic units and Canada. Continued forest management on both federal and State lands will benefit lynx populations in Washington, but this may not completely ameliorate the potential negative effects related to climate change. Considering the recent reduction in lynx habitat and the projected impacts of climate change, experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), mid-century persistence at 30% to 80% (median = 70%), and end-of century (year 2100) persistence probabilities less than 50% (median = 38%) for lynx populations within this geographic unit.

Unit 5 - Greater Yellowstone Area (GYA): As elsewhere, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Because potential habitats in much of this unit already are naturally highly fragmented and perhaps only marginally capable of supporting resident lynx, and because it appears to have never supported more than a small number of residents, its ability to do so in the future is tenuous. Lynx experts felt that the small number of lynx this unit appears capable of supporting and its relative isolation from other lynx populations make it more vulnerable to genetic drift and extirpation due to catastrophic events or demographic or environmental stochasticity. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Considering the factors above, lynx experts felt this geographic unit has the lowest l kelihood of supporting resident lynx into the future in the near term (year 2025; median probability of persistence = 0.52), at mid-century (median = 0.35), and end-of-century (median = 0.15), with a declining

probability of persistence and greater uncertainty with increasing time from present, as in all units.

Unit 6 - Western Colorado: Climate change is expected to affect vegetation and influence snow conditions within the Western Colorado unit. The elevation gradient in Colorado may provide refugia from deteriorating snow quality, depth, and duration throughout the period. Climate models suggest a 40 percent decline in snow persistence, but large areas of snow persistence will remain through the end of the century. Experts suggest that beetle kill and fire will result in unsuitable habitat conditions. However, these areas are likely to regenerate and provide excellent habitat conditions to support hares and lynx. A caveat to future habitat conditions in light of climate warming is that some areas that currently support snowshoe hare populations may experience vegetation type conversion that may not support snowshoe hares. The majority of the experts predicted the persistence of a viable lynx population in the unit by 2100, but further discussion revealed uncertainty about persistence in the unit, and genetic connectivity across ski areas in the unit.

Table 4, below, summarizes factors thought likely to influence the future resiliency of lynx populations in each geographic unit.

Table 4. Future (2050 to 2100) resiliency of individual units of the Canada lynx DPS

Lynx population	Lynx expert probability of persistence	Key evidence	Uncertainties
Unit 1 Maine	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	• 50% decline in habitat expected by 2032, habitat will occur in south edge of range • Slight recovery of habitat by end of century depending on forestry trends • Continued demographic and genetic connectivity to southern Quebec, New Brunswick populations • Climate models predict deteriora ing snow quality, depth and duration below thresholds for lynx; more severe than other units • Lit le elevation refugia	• Future forest management trends and habitat conditions on private forest lands in Maine and Canada • Future shifts in land ownership, forest products markets, and development • Extent and pace of deteriorating snow conditions • Response of hares (pelage mismatch), bobcat and fisher to changing snow regime • Extent and pace of loss of spruce-fir • Future trends in hare populations • Disease and parasites in lynx • Effects of lynx trapping in Quebec
Unit 2 Minnesota	2050 median 80% (range 35 to 100%) 2100 median 35% (range 0 to	• Smaller population could be susceptible to stochastic effects • Habitat conditions on na ional forests will remain stable or improve if managed for softwoods • Continued demographic and genetic	• Future forest management trends and habitat conditions on private forest lands in Minnesota and Ontario • Extent and pace of deteriorating snow conditions

	100%)	connectivity to southern Ontario populations ● Climate models predict deteriora ing snow quality, depth and dura ion below thresholds for lynx ● Lit le elevation gradient: lake-effect snow may retain refugia to 2050 but not 2100	● Response of bobcat and fisher to changing snow regime ● Rate of decline of spruce-fir ● Future trends in hare populations ● Disease and parasites in lynx
Unit 3 Northwestern Montana	2050 median 90% (range 40 to 100%) 2100 median ~78% (range 10 to 100%)	● Some habitat loss from increased wildfire, otherwise habitat will remain stable with USFS management ● Continued demographic and genetic connectivity to southern British Columbia popula ions ● Potential high elevation buffer against climate change ● Recent loss of small sub-metapopulation in Garnet Range ● Increasing fire frequency	● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future trends in hare populations
Unit 4 North-central Washington	2050 median 70% (range 10 to 100%) 2100 median ~38% (range 0 to 90%)	● Habitat and popula ion low because of recent fires; could be susceptible to stochastic effects ● Continued demographic and genetic connectivity to southern British Columbia popula ions ● Elevation is not sufficient to provide long-term refugia from deteriorating snow quality, depth, and duration	● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations
Unit 5 Greater Yellowstone	2050 median 35% (range 0 to 90%) 2100 median 15% (range 0 to 90%)	● Habitat loss from 1980s wildfire, otherwise habitat will remain stable with USFS and NPS management ● No connectivity with Canada populations; little immigration from DPS populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Low quality habitat; dry; low hare populations ● Smaller population could be susceptible to stochastic effects	● Will habitat support adequate landscape hare densities to support lynx? ● Extent to which GYA remains demographically isolated from other DPS populations; immigration from Colorado population ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations ● Extent to which high elevation may

			provide climate and snow refugia ● Extent to which area will be repopulated by the north and/or the south
Unit 6 Western Colorado	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	● Habitat loss from increased wildfire and insect outbreaks, otherwise habitat will remain stable with USFS management ● Isolation from other lynx populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Uncertainty about stability of recently-reintroduced lynx population	● Demographic and genetic effects of isolated population ● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of future insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future trends in hare populations

5.2 Future Conditions - Detailed Descriptions by Geographic Unit

5.2.1 Unit 1 - Northern Maine

Expert Projections of Future Lynx Status

Most experts indicated an initially high and subsequently declining probability of persistence of resident lynx in Maine through the end of the century, with uncertainty (range between lowest and highest probabilities) also increasing over time (Lynx SSA Team 2016, pp. 33-36 and Fig. XX below). Climate change was an overriding near- and long-term stressor.

Increased winter precipitation in the form of rain, reduced snow depth, and reduced snow durations were discussed. Changes in snow conditions will favor bobcats and fisher (a predator of lynx that is limited by deep snow). Experts believed that the effects of climate change would continue to increase as a stressor by mid- to the end of the century (2050, 2100). Snow conditions would continue to deteriorate (especially in the northern Maine unit compared to other areas in the DPS) resulting in increased competition with bobcats and predation by fisher. Climate-induced loss of spruce-fir forest will occur slowly, and an increase in northern hardwood composition of the forest is already occurring. Loss of spruce-fir could be accelerated by forest disturbance (budworm outbreak, forest management affecting large acreages of lynx habitat annually).

Experts expressed a number of near-term stressors (in the next 15 years) related to forest management in northern Maine. Land management objectives were uncertain because of changes in private forest land ownership. Changes in forestry management because of the Maine Forest Practices Act (shift to partial harvesting, increasing acreage harvest, habitat shifting to south) would result in increased fragmentation and declining lynx and snowshoe hare habitat (succession of previous clearcuts from young, dense regenerating stands to mature stands less conducive to high hare densities).

There was uncertainty concerning the severity and response by new landowners to the next spruce budworm outbreak. Experts were concerned that investment landowners would not respond to the pending spruce budworm outbreak like they did in the 1970s (extensive clearcuts, herbicide application). Experts also acknowledged concerns about the effects of the current clearcuts aging past conditions that support hares and lynx.

Hare populations have declined by about half across all stand types (and in adjacent Quebec) since 2006 and apparently have not rebounded. In response, lynx initially had lower reproduction (lower proportion of females breeding, slightly lower litter sizes), but this has not affected home range sizes. Lower landscape hare densities are likely to support lower lynx populations. It is uncertain how hare numbers will cycle or fluctuate in the future.

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of spruce-fir, and bobcat competition are likely to reduce the probability of lynx persistence in this unit. Modeling of current lynx habitat and future habitat trends was more advanced for the Northern Maine Unit than other units. Models indicate that aging of past clearcuts and changes in forest practices to partial harvesting will diminish the current lynx habitat by half in coming decades. Experts and the core team expressed uncertainty about the severity of a pending spruce budworm outbreak, forestry response by investment company landowners, and how this will affect future lynx habitat. More is known about long-term trends in snowshoe hare populations in this unit than others. Hares seem to have declined by half since about 2006 and have remained low. Experts and the core team were uncertain about whether hare numbers would rebound or remain at this lower level, but lower hare densities are affecting demographics (especially percentage of females breeding), which could contribute to population declines. Taking all of these factors into consideration, the experts projected the mean probability of persistence to the years 2025 was greater than 95 percent, to 2050 was about 80 percent (range from 20 to 100 percent), and to 2100 was about 50 percent (range from 0 to 100%)(Lynx SSA Team 2016, pp. 33-34, Fig. 8). The USFWS lynx core team generally agreed with this prognosis with the exception that some were less optimistic about the persistence of this population, especially after reviewing the literature pertaining to climate change in this region.

Commented [MJM31]: These ranges encompass the full range of responses. For the other units, these ranges encompass just the "most likely" points. Why the difference for the Maine unit?

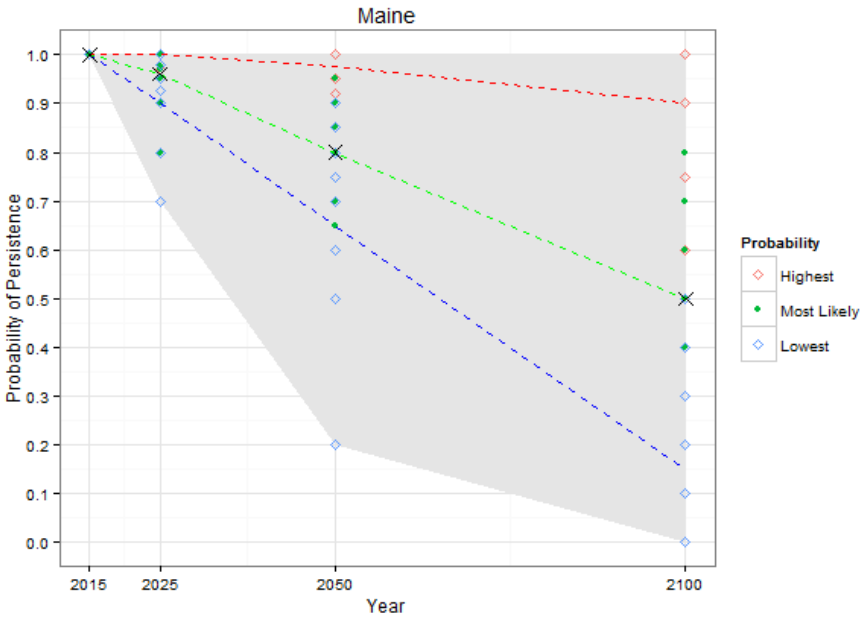


Figure 8. Lynx expert estimates of the probability that the Northern Maine Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Note: In Figure 8, above, and similar figures for the other geographic units, below, points for each of the 10 expert responses, for each of the three probability-of-persistence levels, i.e., highest, most likely, and lowest probabilities of persistence, are represented by the hollow red, filled green, and hollow blue points respectively. The black x mark is the median of the most l kely responses across the experts in each response year. The red, green, and blue dashed lines connect the median of the highest, most likely, and lowest probability of persistence responses across the experts in each response year. The edges of the grey area were defined by the extreme responses, i.e., the range from the largest of the highest probability of persistence responses to the smallest of the lowest probability of persistence responses. The median lines and grey area are provided as a summarizing visualization to aid comprehension of the experts' responses and their range, and should not be viewed as a substitute for individual responses or presented outside the context of the accompanying discussion.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - In response to public concern about widespread clearcutting in northern Maine, in 1989 the Maine Legislature passed the Maine Forest Practices Act (MFPA). The MFPA regulates maximum size of clearcuts (250 acres), separation zones between

clearcuts, harvest plans, and notification to the Maine Forest Service. Clearcuts are not banned, but require varying levels of state permits depending on their size. As a result, the number and acreage of clearcuts completed annually has declined substantially and have been replaced by various forms of partial harvesting (Sader *et al.* 2003, p. 349-350, McWilliams *et al.* 2003, p. 35). In the first decade following passage of the MFPA, the percentage of acreage clearcut in Maine annually declined from 40 percent to 4 percent (Simons 2009, pp. 45-46). The average size of clearcuts has been reduced from >125 acres (Maine Forest Service 1995) to <25 acres (Maine Forest Service 2003, 2005, 2007). Currently, partial harvesting comprises about 94 percent of acres cut annually in Maine (Simons 2009, p. 50). The total volume harvested, however, changed relatively little. The partial harvest that replaced clearcuts include a variety of silvicultural treatments, including both even-aged (e.g., shelterwood) and uneven-aged (e.g., selection) management that result in a wide range of residual stand conditions (Robinson 2006), which have important implications for lynx conservation. Foremost, snowshoe hare densities in partially harvested forests are on average about 50 percent lower (but range from 20 to 90 percent lower) than in regenerating conifer stands created by clearcutting (Robinson 2006, entire; Scott 2009, p. 109, Simons 2009 p. 83), thus reducing landscape hare density and presenting a challenge for future lynx conservation (Simons 2009, pp. 206, 209, 217; Simons-Legaard *et al.* 2016, p. 7-8; Simons-Legaard 2016, entire).

To harvest the same volume of wood annually, landowners must partial harvest many more acres than they would under former clearcutting silvicultural systems. The acres of forest harvested annually in Maine have increased from about 250,000 acres pre-MFPA to 550,000 acres post-MFPA (McWilliams *et al.* 2003, p. 35). Currently, 27 years after implementing the MFPA, much of the 10 million-acre northern Maine landscape has been influenced by partial harvesting. Extensive partial harvesting and aging of the spruce budworm-era clearcuts will reduce landscape hare densities (Simons-Legaard *et al.* 2016, 9-10). If the current landowners continue to harvest using similar methods at and similar rates, habitat for lynx will diminish by about 50 percent by 2030 (Simons-Legaard 2016, pp. 9-10). After 2030, projected outcomes for lynx habitat become more uncertain and depend on assumptions about habitat definitions and harvest rates. Lynx in Maine selected for regenerating, conifer-dominated forest (>75 percent conifer, Vashon *et al.* 2008, pp. 1490, 1492-1494). If one defines lynx habitat as stands having greater than 75 percent spruce-fir, then habitat will decline by about 50 percent by 2030 and remain at about at this level through 2060 (Simons-Legaard 2016, pp. 9,16).

These projections do not consider the next outbreak of spruce budworm. After being low for the last 20 years, spruce budworm numbers are again building toward epidemic levels in Maine, southern Quebec, and northern New Brunswick. Significant defoliation in Maine is expected to begin between 2018 and 2021 (Wagner *et al.* 2014). Although Maine research has clearly demonstrated that landowner response to the last outbreak resulted in unintended, positive benefits for lynx from one to three decades later, our ability to project what effects the next outbreak will have on lynx habitat is still limited. Land ownership has changed dramatically since the last outbreak. To reduce risk from spruce budworm, some financial investment owners may cut younger spruce-fir stands that still support elevated hare populations. Some may be less inclined to intensively manage for spruce-fir. It is unlikely that current landowners will use

widespread use of pesticides to control spruce budworm and herbicides to promote spruce-fir regeneration after stands are defoliated. The MFPA may serve as an additional constraint on motivation to clearcut infested stands, even with recently-enacted changes intended to reduce the regulatory burden for landowners. Landowner response to the pending outbreak will have important implications for the short- and long-term persistence of lynx habitat in the northern Maine unit (Simons-Legaard 2016, pp. 16-17).

Nor do these projections consider a substantial decline in snowshoe hare densities that has occurred in Maine. Snowshoe hare density declined by 69.3 percent from a period of high hare density in 2001-2006 (average of 2.1 hares/ha in regenerating conifer) to a period of lower hare density 2007-2009 (average of 1.0 hares/ha). This decline occurred across all forest stand types and across a broad geographic area of Maine (Scott 2009 p. 36) and the adjacent Gaspe region of southern Quebec (Assells *et al.* 2007, Scott 2009, p. 41-42). Hares remained at these lower numbers through 2013 (D. Harrison, University of Maine, unpublished data). If future hare populations remain low, then Maine habitats will have a lower capacity for supporting lynx.

Climate Change - The northern Maine unit is more vulnerable to snowpack loss because of the lack of elevational refugia (Siren *in* Lynx SSA Team 2016, pp. 15 and experts p. 37) and changes in snow conditions could further restrict their range (Hoving 2002, Hoving *et al.* 2005, Carroll 2007). Wildlife experts in Maine ranked lynx as highly vulnerable to climate change (>66 percent loss in species range/population and extirpation within 50 to 100 years) (Whitman *et al.* 2013, p. 19, 74). Similarly, Carroll (2007, entire) modeled Maine lynx population assuming non-cycling hare populations and snow conditions expected under intermediate to high emissions climate models (Kiehl and Gent 2004, entire). He predicted a 59 percent decline in the lynx population (the non-cycling hare population model) by mid-century because of climate change alone. Maine lacks elevational refugia for lynx under reduced snow scenarios (Carroll 2007, p. 1102), except for the mountains in western Maine where snow refugia may only persist as very small, isolated “sky islands” that would be unlikely to support lynx.

Climate change is affecting the Northeast, and the rate of change is faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46° C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Northeast climate models predict average winter temperature increasing 2.0°C (low emission) to 2.9°C (high emission) by mid-century and 3.1°C (low emissions) to 5.3°C (high emissions) by late century (Notaro *et al.* 2014). Largest increases in temperature are expected in northern Maine (A. Siren, Workshop Notes 2016, Rawlins *et al.* 2012) where temperatures may increase 4.5 to 5.0° F by 2050 (Fernandez *et al.* 2015, p. 3). In response to climate change, interest in wind development has escalated in northern and western Maine increasing threats to high elevation and potential spruce-fir refugia (Whitman *et al.* 2013). Climate conditions are currently at or falling below threshold values needed to support lynx in Maine.

If future trends in increasing temperature and decreasing snow occur, then lynx are unlikely to persist in Maine. Gonzales *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007) and predicted loss of forest and snow conditions able to support lynx in Maine by the end of the century. Although there are uncertainties about future climate warming, lynx populations in Maine are expected to recede northward and decline substantially this century (Vashon *et al.* (2012, p. 60).

Snow Duration. The current average snow duration in Maine is at or below the 4 month snow persistence thresholds believed needed to support lynx (section 4.1.1, Gonzales *et al.* 2007) and is projected to decline. Snow duration is project to continue to deteriorate. Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Snow duration is expected to diminish by 25 percent (low emissions) to 50 percent (high emissions) from current conditions by the end of the century (Hayhoe *et al.* 2006). Similarly, Notaro *et al.* (2014) projected an average decrease of 28 days (low emission) to 47 days of snow cover (high emissions) by the end of the century.

Snow Depth. The current average snow depth in northern Maine is at or below the 270 cm/yr. (106 in/yr) thresholds believed needed to support lynx (section 4.1.1; Hoving *et al.* 2005) and is expected to decline. By the end of the century, large areas of the Northeast will experience 15 percent (low emission) to 25 percent (high emissions) reduced snowfall (Ning and Bradley 2015). Similarly, by the end of the century Notaro *et al.* (2014) projected average snow declines in the North Atlantic Landscape Conservation Cooperative of 59 cm (31 percent) (low emissions) to 92 cm (48 percent) (high emissions) because a higher proportion of winter precipitation will fall in the form of rain rather than snow. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015).

Snow Quality. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015). Snow density and compaction (caused by wet, heavy snow or rain on snow events in winter) will continue to increase in the region in the future (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006, Karl *et al.* 1993).

Loss of Boreal Forest. Climate change is projected to cause a northward contraction of spruce-fir forest in the Northeast with potential negative consequences for both lynx and snowshoe hares (Gonzales *et al.* 2007, entire). Spruce-fir forest is expected to decline substantially in Maine and the Northeast (Ollinger *et al.* 2007 Beckage *et al.* 2008, Tang and Beckage 2010, Whitman *et al.* 2010, p. 12, Jacobson *et al.* 2009, p. 27) or disappear (Iverson and Prasad 2001, pp. 192-193, Prasad *et al.* 2007) because of climate change. Climate change is anticipated to increasingly fragment the boreal forest in northern New England (Iverson *et al.* 2008, Ollinger *et*

al. 2008, Whitman *et al.* 2013). Lynx habitat will decline as boreal forest diminishes (Simons 2009). Even under the lowest emissions scenarios, spruce-fir forest would be greatly reduced by 2100 (Williams and Liebhold 1997, Prasad *et al.* 2007), although some spruce-fir may persist at highest elevations (Tang and Beckage 2010) and along the eastern coast (Jacobson *et al.* 2009) where cooler conditions will prevail.

The spruce-fir forest type has come and gone from New England during the post-glacial period. It nearly disappeared from the Northeast during interglacial warming period 1000 years ago, then moved south into New England only in the past few centuries during the "Little Ice Age" (Schauffler and Jacobson 2002, DeHayes *et al.* 2000). Because of its sensitivity to climate and mobile nature, Iverson *et al.* (2008, p. 403) predicted a significant decline (low emissions) or the disappearance (high emissions) of the spruce-fir forest type in northern Maine in response to climate change.

Spruce (red, black, white) and balsam fir are the most important boreal forest conifer tree species in the Northeast and will be affected by climate change in different ways. Mechanisms of injury to spruce-fir include winter injury from freeze-thaw cycles, spring drought (because of reduced snowpack), and reduced seed germination (Perfect *et al.* 1987, Auclair *et al.* 2010). Thus, the range of spruce-fir is limited by summer heat and drought. Mohan *et al.* 2009 projected that suitable area for balsam fir would decline by 80 percent in 2100 under an average to high emissions scenario. In contrast, Ollinger *et al.* (2008) projected increasing growth rates for balsam fir and red spruce to mid-century, after which they would decline.

The timescale of the spruce-fir decline in the Northeast is difficult to predict because of the many variables that influence shifting of the forest species composition (emissions scenarios, the long lifespan of trees, slowness of tree dispersal, frequency of disturbance, competition from advancing hardwoods and invasive tree species, complex interactions with moisture, and synergistic effects with other pollutants). Arguments in favor of an accelerated decline include evidence that spruce-fir is already in decline (Seymour 1992, Simons 2009) and is being replaced in Maine by northern hardwoods (oak, pine, red maple). The decline of the spruce-fir forest type is accelerated by forest disturbances. A pending spruce budworm outbreak and frequent disturbance from forest management could accelerate conversion to northern hardwoods in northern Maine and eastern Canada (Flannigan *et al.* 2001, Gauthier *et al.* 2015). Other climate-related forest disturbances (forest pests, diseases) could further accelerate conversion to northern hardwoods (Iverson *et al.* 2008, p. 404).

In contrast, some authors note that trees migrate slowly and are long-lived. Therefore, a time lag may occur in shifting forest composition from spruce-fir to northern hardwoods (Mohan *et al.* 2009, Zhu *et al.* 2012). Some northern Maine industrial forest landowners could "adapt" to climate change by intentionally favoring spruce-fir (e.g., by plantations and use of herbicides). McWilliams *et al.* 2005 (p. 8) noted that balsam fir increased in Maine's forest inventory in the 2000s. Forest models projected increases in spruce-fir biomass over the next century because of partial harvesting and periodic budworm outbreaks, but did not take climate change into consideration (Simons-Legaard *et al.* 2013).

Finally, there is uncertainty concerning the influence of climate change on balsam fir, a short-lived, shade-tolerant, conifer that dominates much of the understory in the Acadian forest and is an important component of lynx habitat in the Northern Maine Unit. Climate change will influence precipitation and temperature, forest management strategies, and forest disturbance (fire frequency and spruce budworm), all of which will interact in complex ways to influence the spruce-fir forest at the southern edge of its range. Carter (1996), Iverson *et al.* (1999), and Goldblum and Rigg (2005) documented balsam fir growth rates and growth potential would decline under likely climate warming scenarios (~4 to 5 F degree temperature increase by the end of the century and reduced snow conditions). Some have projected the extirpation of spruce-fir forest types in the Great Lakes States (Scheller and Mladenoff 2005) and New England (Iverson and Prasad 2000). In contrast, balsam fir has prolific seed production following forest disturbance such as harvesting (Seymour 1992), and has proliferated under the current climate and forest management regime dominated by partial harvesting (Olson *et al.* 2013, entire). Balsam fir is a relatively short-lived tree (~100 years), and is unlikely to persist long if climate change affects seed and germinations rates. Given, anticipated climate changes, especially early snow melt and low spring precipitation, fir may increase for the next few decades but is unlikely to regenerate in a the future Maine forest (E. Simons-Legaard, University of Maine, pers. comm. May 31, 2015).

Vegetation Management - Habitat suitable for lynx is expected to decline in the future (see Regulatory Mechanisms section above). By 2020, all of the extensive areas that were clearcut in the 1970s and 1980s will be greater than 35 years of age and no longer support high hare densities. For the foreseeable future, partial harvesting will continue as the primary means of forest management. Although partially harvested forests with well-developed understory structure may provide foraging opportunities via increased prey access (Fuller *et al.* 2007), snowshoe hare densities are approximately 50 percent less in landscapes dominated by partially harvested stands (Robinson 2006, entire; Fuller and Harrison 2010). Thus changing forest management practices will continue to reduce landscape hare density below levels that can support lynx.

Sources of uncertainty concerning future habitat conditions in northern Maine include changes in forest policy, timber harvesting methods, changing timberland ownership, response to budworm outbreaks, and timber markets - all of which have occurred in the recent past and will undoubtedly shape forest management in the future (Simons-Legaard *et al.* 2016, p. 8). Currently, the landscape is owned primarily by financial investors who may be less inclined to intensively manage for spruce and fir after the next outbreak of the spruce budworm (Wagner *et al.* 2014).

The dramatic shift from clearcutting to partial harvesting presents a challenge for lynx conservation in this unit for the next several decades. Lynx, habitat is expected to peak and remain stable through about 2020 (Simons 2009, Simons-Legaard *et al.* 2016 p. 6). After 2020, aging of the former clearcuts and extensive partial harvesting are projected to result in a 50 to 65 percent decline in lynx habitat by 2032. Lynx habitat will decline from about 9.5 percent of

the landscape (current condition) to about 4.5 percent of the landscape (Simons-Legaard 2016). By 2032, the Northern Maine Unit may support less than half the lynx population as it does today (Simons 2009, p. 209, 217).

In the future, lynx habitat will be fragmented into smaller, isolated parcels, and will shift southward into areas occupied by bobcats and fishers where snow conditions are unlikely to support lynx (Simons 2009, Simons-Legaard *et al.* 2016, Simons-Legaard 2016). By 2022, the number of patches of high quality hare habitat will increase by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6). The proximity index of high quality habitat patches will decline by 78 percent within lynx home ranges. Although lynx habitat is peaking, fragmentation is diminishing its ability to support lynx (Simons-Legaard *et al.* 2016).

Beyond 2030 assumptions concerning future climate change, land ownership, and harvest rates introduce greater uncertainty. The most optimistic forest management models (greatest harvest rates, no climate change, no spruce budworm) project that lynx habitat will decline over the next few decades then gradually increase to about 10 percent of the landscape by 2060. The most most pessimistic models (lowest harvest rates, no climate change, no spruce budworm) project about 5 percent of northern Maine will have high quality hare habitat (Simons-Legaard 2016, entire), although the habitat will be much more fragmented and smaller patch size (Simons-Legaard *et al.* 2016).

Softwood plantations could offset losses in spruce-fir and become a form of adaptation to climate change. Jack pine plantations are extensive in adjacent New Brunswick (Etheridge *et al.* 2005, p. 1966). A forest company that has planted extensive spruce plantations in New Brunswick and recently purchased nearly 1 million acres of forestland in northern Maine where they are doing the same. Spruce plantations are becoming more common on this ownership in Maine, but not others. Stand structure and intensive management of plantations are highly variable (e.g., pruning, thinning, herbicide treatments), thus hare density and use by lynx vary (Roy *et al.*) Hares can achieved higher densities in plantations depending on the amount of lateral cover, but for shorter periods of time; ~10 to 17 years after cutting and planting in New Brunswick (Parker 1984, p. 163) and 15 to 25 years in Quebec (Roy *et al.* 2010, p. 585). This is in contrast to ~15 to 35 years in naturally regenerating spruce-fir stands after harvest (Simons-Legaard *et al.* 2016, p. 4). The future of plantations in the northern Maine unit is uncertain. Most investment landowners have short-term investment horizons and are unlikely to invest in plantations.

Natural stand-replacing disturbances are rare and infrequent and, other than spruce budworm outbreaks, are unlikely to significantly affect future habitat conditions (Hoving *et al.* 2004).
A spruce budworm outbreak is projected to reach epidemic proportions in 2018 to 2021. The epidemic has already affected 10 million acres of spruce-fir in southern Quebec, immediately north of Maine (Wagner *et al.* 2014, entire). The last outbreak in the 1970s and 1980s killed millions of acres of spruce and fir forests in the northern Maine unit. Maine's 5.8 million acres of spruce-fir stands across the state are at risk of some level of defoliation. The intensity of the

next outbreak is uncertain, although some project a weaker outbreak because spruce and fir trees are younger and less susceptible and there is a higher hardwood component in northern Maine forests (Wagner *et al.* 2014, p. 21-27). A typical outbreak lasts for a decade.

Forest management strategies for addressing the coming outbreak vary and include applying insecticides (although land area sprayed is expected to be small compared to the previous outbreak), pre-emptive cutting of mature spruce-fir before defoliation, stop precommercial and commercial thinning, and salvaging dead and diseased trees (Wagner *et al.* 2014, pp. 5-6). An aggressive forest management response (or not) will greatly affect future outcomes for lynx habitat (see section 5.2.1). The next budworm outbreak and subsequent forestry response is a disturbance agent that may accelerate changes in forest composition influenced by climate change, especially toward increased northern hardwood and reduced spruce-fir. The nature of landownership is greatly changed from the 1970s and 1980s, and landowner response is expected to be diverse depending on their objectives and investment horizons. The pending budworm outbreak cast additional uncertainty on the status of lynx habitat beyond 2030.

Climate change, forest management and budworm outbreaks will interact to influence the future trajectory of spruce-fir forest in Maine. All three variables have yet to be modeled simultaneously (K. Legaard, UMaine, personal communication). Assuming current forest management trends persist to the end of the century, spruce-fir dominated forest is expected to continue to decline (Legaard *et al.* 2013, entire). The combination of budworm-induced mortality and salvage harvesting will have a negative effect on spruce-fir (Legaard *et al.* 2013, entire). However, after a budworm outbreak the biomass and area of mixed-hardwood/softwood forest would be expected to increase through this century primarily because of regenerating balsam fir (see discussion above) (Legaard *et al.* 2013). Mixed forests having a high hardwood component are not believed to support high hare densities (Scott 2009, p. 109) or be preferred by lynx (Vashon *et al.* 2008, pp. 1492-1493). It is uncertain whether lynx can adapt to lower landscape hare densities associated with mixed hardwood-softwood forest. They may persist, but at lower densities as they currently do in the western units of the DPS. However, the probability of persistence is further diminished by deteriorating snow conditions and increased populations of bobcats and other competitors.

Fire Management - Suscept bility of the northern Maine unit to fire may be enhanced by a severe spruce budworm outbreak because of the amount of dead and dying spruce-fir (Stocks 1987), although there were no large fires after the last outbreak. Fire risk is currently very low in this unit and a continuous decrease in fire frequency is predicted with climate change in eastern Canada because of increased precipitation and decreased drought (Bergeron and Flannigan 1995, Flannigan *et al.* 1998). Climate is expected to become more variable during the next century (Gregory & Mitchell 1995; Gregory *et al.* 1997), which could create fire conditions in unusually dry years (Flannigan *et al.* 1998, p. 475). Maine's policy is to immediately suppress wildfire, thus large, stand-replacing fires are expected to be infrequent in this region. Notable large fires in Maine include a 3 million acre fire in 1825 and 200,000-acre fire in 1947.

Habitat Fragmentation - The future of the 10 million-acre, sparsely populated “North Woods” of Maine is highly uncertain and has been the subject of intense public debate (Baldwin *et al.* 2007). Land use and zoning in the state’s “unorganized townships” are the respons bility of the Land Use Planning Commission (LUPC) in the Maine Department of Conservation. The LUPC revised its Comprehensive Land Use Plan (De2010), and described principal values in guiding future land management decisions: maintaining working forests, provide for traditional recreational opportunities, protect high-value natural resources, and encourage long-term conservation. The North Woods has long been considered a public resource or “commons,” even though privately owned (Judd 2007, p. 9). This land was traditionally owned by a few large timber companies, but since the 1980s there has been rapid turnover in ownership largely by investments companies and subdivision of large parcels (Hagan *et al.* 2005). Financial investors, such as REITS and TIMOs focus on maximizing the asset value of timberlands and are increasingly likely to seek revenue from non-timber resources if they will generate a higher return. These new owners operate over relatively short time horizons (e.g., 5 to 15 years) and are willing to consider multiple means of monetizing their asset, including development and real estate sales (Legaard 2013, entire). If left unchecked, these pressures may continue to promote dispersed residential development throughout this region. Parcelization and subdivision has increased, particularly in the southern third of the jurisdiction (Maine Department of Conservation 2010, p. 72-73). The LUPC has limited ability to address stressors on Maine’s North Woods, including resale and subdivision trend. This trend is likely to continue into the foreseeable future and will make management of large, forested landscapes for Canada lynx even more difficult.

Historically, development has stayed mostly on the edges of the North Woods jurisdiction with exception of scattered seasonal dwellings and sporting camps in the interior, but this could change in the future. Between 1971 and 2005, the LUPC permitted 8,136 new dwellings in unorganized townships — an increase of 66 percent in the number of residences during this time period (Maine Department of Conservation 2010, p.80). Between 1971 and 2005, the LUPC issued 1,353 development permits for new uses scattered throughout the unorganized townships (Maine Department of Conservation 2010, pp. 97-99); most (42 percent) being recreational facilities (boat launches, campsites, gatehouses, recreational lodges). Most development has occurred in areas that abut organized communities and near public roads. Within the interior most development has occurred on long lakeshores and waterfront. However, the amount of hillside and ridge development is growing and this trend is likely to continue (Maine Department of Conservation 2010, p. 136), which will further fragment lynx habitat.

We have an incomplete understanding of the effects of outdoor recreation on lynx and their habitat (ILBT 2013, p. 80). Future trends in outdoor recreation in northern Maine are also uncertain (Vail 2007, entire). A portion of the North Maine Woods is a gated road system that encompasses about 3.5 million acres. Visitation by outdoor recreationists is currently about 175,000 per year and declining. Likewise, visitors to Baxter State Park and the Allagash Wilderness Waterway have declined (Vail 2007, p. 107). Aside from a vigorous discussion of a proposed national park or monument, national heritage area, or a master tourism plan for the area (Vail 2007, pp. 112-113), there is likely to be stagnant or declining participation in

traditional outdoor recreational activities in the future (Vail 2007, p. 107). Snowmobiling may be an exception because of declining snow (see climate change section). The effects of new or expanded downhill ski development on fragmentation of lynx habitat are expected to be minimal. Three alpine ski resorts occur within the unit on the southern margin of lynx habitat: Saddleback Mountain Ski Area in Sandy River Plantation near Rangeley, Sugarloaf Mountain Ski Area in Carrabassett Valley, and Sunday River Skiway in Newry and Riley Township. Further development of ski areas is unlikely in the western Maine mountains. Future trends in outdoor recreation and associated effects on lynx, hares, and their habitat are uncertain in the northern Maine unit

Within the last five years, two landowners developed concept plans for rezoning for large-scale development hundreds of house lots and resort development within the lynx critical habitat. One concept plan would construct 975 houses and two resorts on about 3,500 acres and a 363,000-acre conservation easement. A second concept plan would allow development on about 1900 acres of land and a 14,600 acre conservation easement. Although these developments have not been built, they may portend future trends in land use.

Energy production is emerging as a potentially significant economic factor in this unit, with grid-scale industrial wind power, biomass, biofuels, and other energy sources offering new opportunities to utilize natural resources. Wind energy resources are high within the lynx critical habitat (National Renewable Energy Laboratory 2010, http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mecitation ; last accessed 5/25/2016), and wind development in the lynx critical habitat are likely to accelerate in the foreseeable future. Mining is not a traditional land use but a large operation is being considered at one location in the lynx critical habitat. Extraction operations for gravel (for road building) are widely-scattered throughout the unit.

The lynx critical habitat is heavily roaded, particularly with forestry roads. While accurate numbers are difficult to obtain, approximately 1,500 miles of public roads and over 20,000 miles of private roads exist within unorganized areas of Maine (Maine Department of Conservation 2010). There has been discussion of an east-west limited access highway through northern Maine and extending Interstate 95 north from Houlton to Presque Isle, which, if constructed, would further fragment habitat (Maine Department of Transportation 1999, Beck *et al.* 2012, p. 38).

An increasing area of the lynx critical habitat area is likely to be placed under conservation easements that will limit future development and fragmentation of lynx habitat. Maine has the largest amount of land under easement of any state, and there are about 2 million acres of conservation easements in lynx habitat in northern Maine (Pidot 2011). Continued expansion of areas under conservation easement is uncertain and will depend on willing landowners and funding available for purchase of easements

All of development trends portend increased fragmentation of lynx habitat in the northern Maine unit. As habitat is fragmented, it will become increasingly difficult to influence landscape-scale forest management that could benefit lynx.

5.2.2 Unit 2 - Northeastern Minnesota

Expert Projections of Lynx Status

The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century (Lynx SSA Team 2016, pp. 37-38 and Figure 9, below). Near term drivers of the projected decline were reduced quality, quantity, and persistence of snow, competition from bobcats, disease (*e.g.*, lungworm, liver fluke, feline leukemia), and forest insects. Long term drivers of the projected decline were reduced the quality, quantity, and persistence of snow, competition from bobcats, loss of spruce-fir forests, wildfires, and climate change. Climate change was primarily associated with loss of boreal forest but could potentially also increase disease or insect outbreaks, and is likely to affect the amount of precipitation falling as good quality snow in the area of the state supporting lynx habitat. The connection to lynx in Ontario reduces the likelihood of local extirpation in this geographic unit, but the likelihood would increase if connectivity was compromised. Taking all factors into consideration (i.e., loss of boreal forest, competitions, disease and insect outbreaks, loss of snow), the experts projected the mean probability persistence to the year 2025 was greater than 90 percent, to 2050 was 80 percent (ranging from 60 to 90 percent), and would decline to approximately 35 percent (ranging from 10 to 60 percent) by 2100 (Lynx SSA Team 2016, pp. 37- 38).

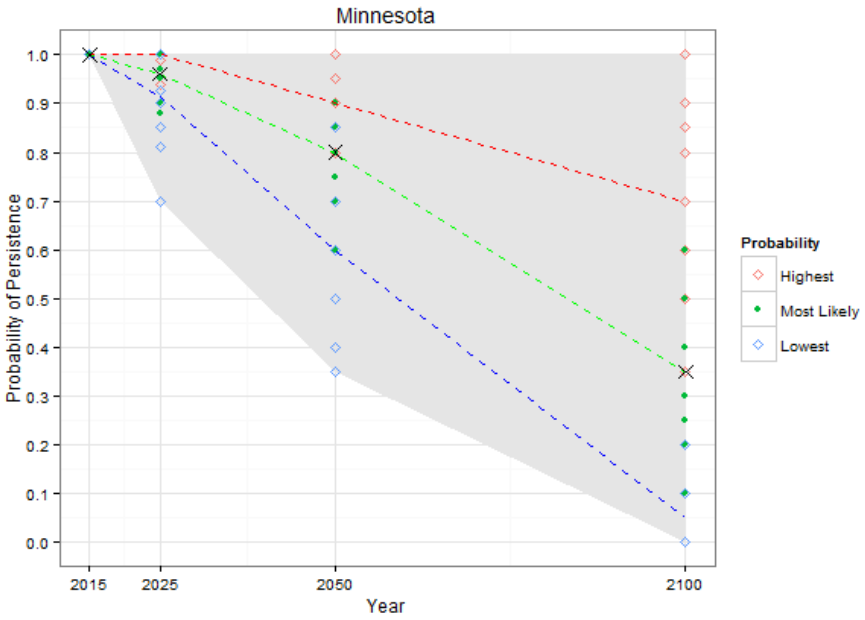


Figure 9. Lynx expert estimates of the probability that the Northeastern Minnesota Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - In Minnesota, the vast majority of lynx habitat that supports long-term persistent lynx breeding population is administered by the Superior National Forest. This area includes designated critical habitat (79 FR 54782). The SNF is currently implementing the 2004 SNF Plan (USDA 2004a), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat and the Superior National Forest has a long-term commitment for doing so. If the SNF continues to follow vegetation and wildland fire management and other applicable recommendations under the 2000 LCAS (or the updated 2013 LCAS or subsequent updates) in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. Management of lynx and its habitat on SNF land will remain in place until the forest amends or revises their individual LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended Forest Plans (LPMPs).

Although outside of areas considered to be core lynx area (i.e., where lynx are persistent and are reproducing) in the Great Lakes, the Chippewa National Forest and the Chequamegon-Nicolet National Forest Forest Plans also include direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs (USDA CNF 2004, USDA CNNF 2004).

Additionally, the Minnesota Department of Natural Resources (MN DNR) manages approximately 36 percent of the lynx habitat in this unit and private landowners make up about 16 percent of unit. Under the Sustainable Forest Resource Act of 1995 (revised in 2014), the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2013, entire; MFRC 2014, entire) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx (MFRC 2014, pp. 4-5). It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue. Private landowners, however, do not have an official commitment to land management. We cannot say with any certainty what proportion of privately owned land will follow those guidelines into the future, because following the guidelines is voluntary.

The NPS manages Voyageurs National Park, which is also within the Minnesota unit. Voyageurs National Park protects an area of 882 km^2, of which 534 km^2 (62 percent) is covered by forests and other uplands (Moen *et al.* 2012, p. 348), but does not have lynx specific direction in its management plan (NPS 2002, entire). The National Park consults with the FWS to consider the effects of any projects to lynx (NPS 2002, p. 26) and is anticipated to do so as long as the species is listed under the ESA. Lynx documented on and near Voyageurs National Park are probably transient animals (Moen *et al.* 2012, p. 348).

Approximately 1 percent of the Minnesota unit is managed by the Grand Portage Band of Chippewa, who has been actively working on lynx conservation since 2004. On-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire) and are expected to continue into the future.

In response to a 2008 court ruling, the MN DNR began to draft a plan to address incidental take of lynx that may result from otherwise legal trapping in Minnesota. This plan is still under development by the MN DNR and will be designed to reduce the likelihood of incidental take from trapping (LCAS 2013, p. 49).

Climate Change - The direct and indirect effects of climate warming are expected to affect lynx in Minnesota (Siren *in* Lynx SSA Team 2016, pp. 15 and Moen *in* Lynx SSA Team 2016, p. 19) and could further restrict their range. Since the time of listing, new information on regional climate changes and potential effects to lynx habitat has been developed (e.g., Danby & Hik 2007; Gonzalez *et al.* 2007; Knowles *et al.* 2006, Notaro *et al.* 2015), and this new information

suggests that climate change may be an issue of concern for the future conservation of lynx because lynx distribution and habitat is likely to shift upward in elevation within its currently occupied range as temperatures increase (Gonzalez *et al.* 2007, entire). Greatest stressors of climate change include diminishing snow depth, quality and duration; competition from bobcats and other carnivores, hybridization with bobcat (Schwartz *et al.* 2002); loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing forest conditions in Ontario.

Gonzales *et al.* (2007, entire) modeled distr bution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007, pp. 44-47) and predicted loss of forest and snow conditions able to support lynx in Minnesota by the end of the century. Notaro *et al.* (2015, pp. 1668-1669) projected changes in lake effect snowfall using downscaled climate models (Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4; Elguindi *et al.* 2011 and Giorgi *et al.* 2012 as cited in Notaro *et al.* 2015) for the Great Lakes Basin. Siren (*in* Lynx SSA Team 2016, p. 15) stated that climate models show an increase in lake effect snow in the eastern Great Lakes until 2050, with a decline later in the century, with an overall decline in the amount and duration of pack in the Midwest. Although there are uncertainties about future climate warming, lynx populations in Minnesota are expected to recede northward and decline over the next century (Lynx SSA Team 2016, pp. 37-38).

Lynx require at least four months (120 days) of continuous snow coverage (Gonzales *et al.* 2007, p. 7). Snow cover days of 1 inch or greater in northern Minnesota (1959 -1979) ranged from 130-160 days, of 6 inches or greater ranged from 85 to 130 days, of 12 inches or greater ranged from 50 to 100 days, of 24 inches or greater ranged from 10 to 30 days (Kuehnast *et al.* 1982, pp. 7-9). In the future, Notaro *et al.* (2015, p. 1675) projected a general reduction in the frequency of heavy lake-effect snowstorms during the twenty-first century, with the exception of projected mid-century increases around Lake Superior when local air temperatures are expected to remain low enough for precipitation to largely fall in the form of snow. The snow season in the Great Lakes basin is likely to become substantially compressed during the twenty-first century with dramatic increases in rainfall (Notaro *et al.* 2015, pp. 1676-1678). The Minnesota unit may be more vulnerable to snowpack loss due to lack of elevational refugia (Siren *in* Lynx SSA Team 2016, p. 15).

Normal annual snowfall from 1981-2010 in northeastern Minnesota ranged from 140 to 241 cm per year (55 to 95 in/yr.) http://www.dnr.state.mn.us/climate/summaries_and_publications/normals_snow_1981_2010.html, accessed 24May2016) and is projected to decline across the Great Lakes Basin (Notaro *et al.* 2015, p. 1675). Snow quality ("fluffiness") is projected to deteriorate in the Great Lakes. Notaro *et al.* (2015, pp. 1671-1674) projected a dramatic decline of Great Lakes ice cover that will become confined to the northern shallow lakeshores during mid-to-late winter by the end of the century. Ultimately, this leads to increased rainfall, not snowfall, as these projected reductions in ice cover and greater dynamically induced wind fetch lead to enhanced lake evaporation and total lake-effect precipitation (Notaro *et al.* 2015, pp. 1674-1678).

Climate change is projected to cause some northward contraction of boreal conifer forest in Minnesota (Gonzales *et al.* 2007, p. 16, 18) with some potential loss of habitat at the southern portion of lynx habitat in the state (Gonzales *et al.* p. 2007, p. 19). According to Frelich (*in* Lynx SSA 2016, p. 14) Minnesota is likely to lose boreal biome, potentially within the next 60 to 70 years, with unmitigated climate change. According to Gonzales *et al.* (2007, p. 8), the Superior National Forest is a potential refugia for lynx in the lower 48 states, however, when compared to other regions.

Vegetation Management - Vegetation management conducted under the Forest Plan currently will likely continue into the future on Forest Service lands in Minnesota. These activities include timber harvest, such as thinning, clear-cutting, shelterwood, partial cut, and uneven-aged cutting; wildlife restoration projects that involve tree cutting, shearing, burning, seeding, and planting; prescr bed burning for ecological purposes, hazardous fuel reduction, and site preparation; mechanical site preparation.

Vegetation, timber, and minerals management authorized under the Forest Plan has the potential to adversely affect lynx and lynx critical habitat by reducing habitat quality for denning, foraging, and dispersal; disrupting travel, resting, and foraging patterns; disturbing denning females and reducing habitat quality for lynx prey species, especially snowshoe hare. Depending on the timing, frequency, intensity, extent, amount, or other conditions, impacts may be variable among similar projects. Using the LCAS as a basis, the Forest Plan has incorporated a number of components that would reduce the risk of those impacts into the future. We expect that management direction for lynx addressing vegetation management on national forest system lands will be incorporated into the revised or amended future plans, using LCAS as a basis.

Future Forest Plan revisions will likely maintain broad direction to design and implement vegetation management projects to maintain or restore conditions for lynx foraging and denning habitat and to maintain or improve juxtaposition of required habitat types and connectivity.

Over the long term, the Forest Plan will alter vegetation patterns on the landscape. Suitable hare habitat was predicted to decrease over time with implementation of the Forest Plan, but has actually increased since 2004 (USFWS 2011, p. 51). Management activities that create unsuitable conditions for hare generally include clear-cut and seed tree harvest, and might include management-ignited fire, mechanical site preparation, salvage harvest, and shelterwood and commercially-thinned harvest, depending on unit size and remaining stand composition and structure. Suitable hare habitat is predicted to remain above the range of natural variation, which is essentially a description of conditions that existed prior to European settlement (1600 – 1900 A.D.) of the area (USDA 2004b, p. 105). Further, unsuitable habitat for lynx would vary only slightly with continued implementation of the Forest Plan and would remain distinctly below the maximum of 15 percent unsuitable in a decade prescribed in the LCAS and incorporated into the Forest Plan. Current (2010) unsuitable habitat levels are below what was predicted in the 2004 (USFWS 2011, pp. 51-52). Because suitable habitat on National Forest lands alone is

such a high percentage within LAUs and the Superior National Forest is the majority landowner within most LAUs, we expect that in the future, the Forest would not approach the LCAS maximum of 30 percent of lynx habitat on all ownerships in an unsuitable condition within an LAU at any time, which would be ensured by corresponding guidance in the Forest Plan.

Wildland Fire Management - Unlike the Maine unit, the susceptibility of the Minnesota unit to fire may be reduced by periodic spruce budworm outbreaks. Measurable defoliation due to spruce budworm has occurred in Northeastern Minnesota continuously since 1954 (MN DNR http://www.dnr.state.mn.us/fid/july2014/articles.html) and is expected to continue into the future. Modeling to evaluate the relative strength of interactions between spruce budworm outbreaks and fire disturbances in the BWCA showed that budworm disturbance can partially mitigate long-term future fire risk by periodically reducing live ladder fuel within the forest types of the BWCA but will do little to reverse the compositional trends caused in part by reduced fire rotations there (Sturtevant *et al.* 2012, pp. 1286-1292).

The Superior National Forest manages for wildfires through preventative measures such as fuels reductions, but does not manage for wildfires in the BWCAW. Natural successional changes and those associated with natural phenomena, such as wildfire or windstorms, are and are expected to continue to be the dominant force in ecosystems on the BWCAW.

Habitat Fragmentation - Ravenscroft *et al.* (2010, p. 329) considers northeastern Minnesota forest landscape as largely un-fragmented. The BWCAW remains intact and contiguous with Canada. Within the SNF, natural disturbances and vegetation management activities make up most of the annual human-caused fragmentation in actively managed portions of the Forest. These areas typically re-vegetate within three to five years, depending on the forest type and number and type of activities (USDA 2011, p. 119). The Forest Plan (USDA 2004a, Appendix E) provides direction on limiting lynx habitat fragmentation and the Forest actively consolidates habitat through land acquisitions and exchanges.

5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Expert Projections of Future Lynx Status

Because of its connectivity to lynx populations and habitats in Canada, its large geographic extent, and the relatively large number and broad distribution of resident lynx it is thought to support, future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely (Lynx SSA Team 2016, pp. 25-34). When considering the probability that this unit would continue to support resident lynx in the future, experts noted that despite projected losses of favorable forest and snow conditions, climate models project that some boreal forest will persist in this unit and that it will maintain some areas of suitable snow into the future. Experts also noted that lynx in this unit primarily occupy public lands, which are actively managed for lynx into the future. Experts also considered recent and projected future increases in wildfire frequency, size and intensity.

As for most other geographic units, all experts indicated an initially high and subsequently decreasing probability of the persistence of resident lynx in this unit, with increasing uncertainty over time, but a higher probability of persistence at all time frames than other units. All experts predicted near-term (year 2025) persistence probability >= 95%, mid-century persistence at 70% to 100% (median = 90%), and end-of-century persistence probabilities >= 50% (median = 78%) (Figure 10, below).

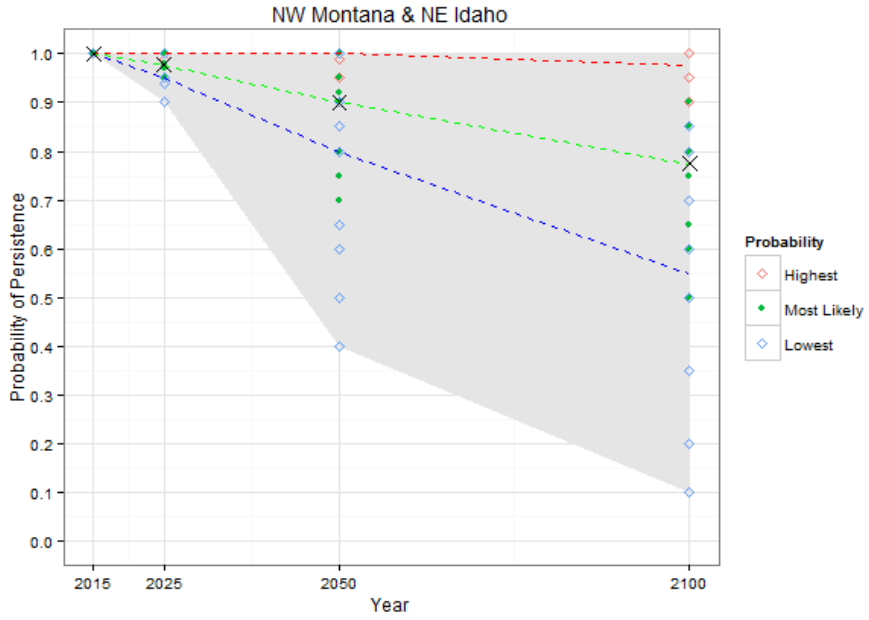


Figure 10. Lynx expert estimates of the probability that the Northwestern Montana/Northeastern Idaho Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Overall, experts assigned a higher probability of persistence in this unit compared to the other geographic units. Most lynx habitats in this unit occur on federal lands that are managed for lynx conservation, but one expert noted that little has been done to document whether lynx are responding to this management. The recent sale of large tracts of private commercial timberlands in the central part of this unit to The Nature Conservancy has increased protection for lynx via conservation easements managed for lynx. Habitats in some areas should improve in the near future as previously cut or burned areas mature into dense stands. Unlike the Maine and Minnesota geographic units (but similar to most other western units), high elevations in this unit could buffer the effects of climate change by providing for the upslope migration of lynx habitats and snow conditions that climate models predict. However, this would result in even patchier and more isolated islands of habitat in high elevation areas that would be more prone

to extirpation due to catastrophic or stochastic events. Competition from coyotes and bobcats seem to be less of a concern for this unit.

This unit has unimpeded connectivity with Canada, but some experts questioned whether this geographic unit depends on intermittent immigration of lynx from Canada, and whether the historic lynx population cycles in Canada believed to have fueled such immigration are still occurring or will into the future. There doesn't appear to be much demographic input from recent cycles. There is evidence of lynx from this unit moving north into Canada, but little evidence of demographic interactions among the three subpopulations (Purcell Mountains, Seeley Lake, and Garnet Mountains) in this unit. Experts noted that the Garnets Mountains subpopulation at the southern end of this unit may have recently become extirpated.

Discussion among experts indicated that fire was more of a concern for this area. Increased fire extent and severity or other catastrophic events and small subpopulation effects in separated mountain ranges could affect lynx persistence in the future in some parts of this unit. Fire exclusion in this area for the last 100 years likely resulted in the accumulation of fuels; however, this unit may have a reduced probability of a catastrophic fire over time because of recent changes in management and recent fires that may have reduced fuels. Out to the year 2050 and beyond, some experts felt there may be more pressure on lynx populations in this unit from continued increases in fire extent and severity. Other experts expressed a different opinion of the overall effect of fire in this unit, indicating that it may actually improve habitat over time, and that whether fires improve or degrade habitat depends on the frequency, intensity, size and spatial extent of future fires.

Experts discussed the possibility for increased precipitation and warmer temperatures in this unit because of climate change, and how this might affect lynx habitats. Boreal/subalpine forest may move up in elevation as described above; however, experts expected a shift in forest composition and diminished lynx habitat quality in future with climate change. It is unknown how much the distribution of dry ponderosa pine (non-habitat for lynx) will increase with climate change, but it is likely to happen at some level. One expert cautioned that some climate modelers estimated that vegetation will lag about 50 years behind the projected changes in temperature and precipitation. Snow levels in lower elevation areas are already decreasing in some areas, which could lead to smaller areas for lynx to use in winter in the future.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - Federal, State, and Tr bal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Because most (84 percent) of this geographic unit consists of federal lands, the regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations in this unit. When Forest Service, Park Service, and BLM management plans are revised or amended, they require opportunities for public participation in accordance with several statutes (e.g., the National Environmental Policy Act [NEPA], National Forest Management Act [NFMA], National Parks and

Recreation Act, Federal Land Policy and Management Act [FLPMA]) (USFWS 2014 pp. 26-34, also see 3.1, above). If plan amendments or revisions may affect listed species, management agencies must consult with the Service in accordance with section 7 of the ESA. If in the future the lynx DPS is determined by the Service to be recovered and the protections of the ESA no longer necessary (i.e., if the DPS is removed from the *Federal Lists of Endangered and Threatened Wildlife and Plants*), the ESA requires the Service, in cooperation with the States, to monitor the DPS for a minimum of five years to assess its ability to sustain itself without the ESA's protective measures. If, within the designated monitoring period, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (BLM 2004a, pp. 2-3; USFS 2007, Attachment 1, p. 2). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore the capacity of the areas that historically or recently supported resident lynx populations, including the Northwestern Montana/Northeastern Idaho Geographic Unit, to continue to do so in the future.

On non-federal lands (about 16 percent of this unit), as described above (sections 3.1.1 and 4.2.3, Habitat Status), recent acquisitions and conservation easements on some of the private lands in this unit will also reduce the likelihood of future adverse impacts to important lynx habitats. Similarly, the MTDNRC HCP includes a 50-year commitment to manage most (64

percent) State lands in this unit to conserve lynx foraging, denning, and connectivity habitats. Additionally, the Confederated Salish and Kootenai Tribe's objective to manage wildlife and habitats on the Flathead Reservation for future generations (section 3.1.2, Tr bal Management, above) suggests continued management to conserve lynx habitats on Tribal lands.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will continue to support resident lynx into the future.

If the DPS were to be delisted in the future, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.3, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 41). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely compromising this unit's continued ability to support resident lynx populations.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, and to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on future lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of these landscapes to continue supporting resident lynx may be compromised, and lynx populations may be unable to persist until favorable vegetation conditions return. This is especially true where habitats and populations are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much if not all of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced (as is suspected) by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will reduce this geographic unit's ability to continue to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx populations in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears l kely that continued climate warming will reduce future habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal and most non-federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.3, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current federal management restricts, with few exceptions, fire management (fuels reductions,

prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.3, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although this increased wildfire activity does not appear to have diminished this unit's current ability to support resident lynx, it could do so in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distr bution of higher-quality habitats and potentially compromising this unit's ability to support a resident lynx population until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.3, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier

anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – As described above and in section 4.2.3, maintaining connectivity between this geographic unit and lynx populations in Canada is thought to be important, although it is uncertain if or to what degree immigration of lynx from Canada is essential to the persistence of lynx in this unit. A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected.

Although the extent to which this factor may influence lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area (λ = 0.92, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. If this growth rate was applied continuously to a hypothetical resident population of 250 lynx (the midpoint of the range in the number of resident lynx this geographic may support based on expert opinion [Lynx SSA Team 2016, p. 41]), the population would decline to 100 lynx after 11 years, about 50 lynx after 20 years, and roughly 20 individuals after 30 years. Vulnerability to demographic, environmental, and genetic stochasticity would increase as lynx numbers decreased, resulting in an increased l kelihood of functional extirpation of lynx from this unit. However, as noted above, the lynx population in the Purcell Mountains in the northwestern part of this unit was estimated to be increasing (λ = 1.16, 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) over the last four years of the period for which the Seeley lake population was estimated to be declining. In the absence of information on historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.4 Unit 4 - North-central Washington

Expert Projections of Future Lynx Status

Compared to the previous units, most expert graphs showed a lower probability of persistence for this unit over the short term, and then lower probability of persistence along with increasing uncertainty by 2100, reflecting a more pessimistic outcome for this unit compared to previous units (Figure 11). Experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), and mid-century persistence at 30% to 80% (median = 70%). All experts predicted end-of-century persistence probabilities less than 50%, with a median of 38%, by 2100 (Figure 11). However, one expert predicted an increase in persistence probability by mid-century as habitats impacted by recent large-scale fires regenerate into optimal hare-lynx habitat.

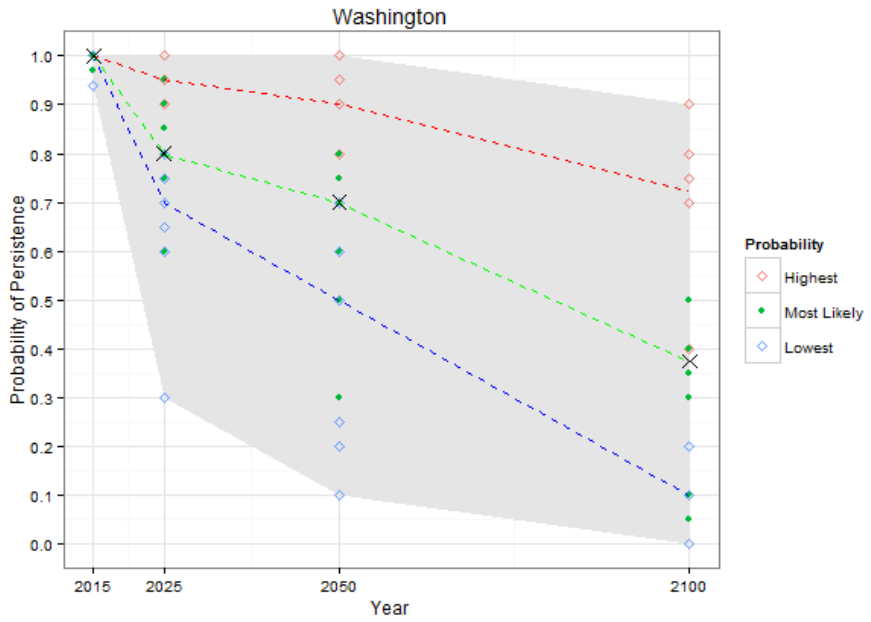


Figure 11. Lynx expert estimates of the probability that the North-central Washington Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

The probability of lynx persistence in this unit could decrease sharply over the next 10-20 years because of extensive recent fires in lynx habitats and the time needed for these areas to regenerate back to good hare/lynx habitat. After that, the probability could rebound (or decline more slowly) over the longer term as these large areas return to prime habitat providing high hare densities. The current small population is likely at greater risk of extirpation because of stochastic events, particularly if large fires in lynx habitat continue to occur in the near future as they have in the recent past. A small population also could be more susceptible to disease, though none has been documented among lynx in this unit. Experts discussed the extent to which small lynx populations could be reduced before they would become highly susceptible to stochastic demographic effects. It was suggested that 15-20 breeding individuals might be the minimum needed to avoid such susceptibility. Unimpeded connectivity between Canada and the Okanogan area of this unit could allow lynx to repopulate currently-unsuitable areas after the habitat recovers. Lynx in this unit are l kely the southern portion of a larger population in Canada, not really a separate, isolated small population. Factors that influenced expert

persistence probabilities for this unit included fire, habitat loss, and the future loss of favorable snow conditions predicted by climate change models.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - As stated previously, it appears that, currently, adequate protective regulatory mechanisms are in place in this geographic unit. Looking to the future, relative to the regulatory risks to lynx, we do not anticipate the existing regulatory protections for lynx to diminish. We anticipate that either the CA will remain in place (and/or be extended), or the OWNF and CNF will revise or amend their respective LRMPS incorporating direction for lynx management similar to what has occurred with other 18 National Forests in Idaho, Montana, Utah, and Wyoming. These 18 National Forests amended their respective LRMPs with lynx management direction known as the Northern Rockies Lynx Amendment (NRLA) in 2007. The NRLA incorporated management recommendations from the LCAS, with modifications based on the advent of new information pertaining to the management of lynx. Currently, both the OWNF and CNF are in the process of amending or revising their LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended LRMP. Also, as discussed previously, the WADNR has developed and is implementing its 2006 Lynx Plan. The WADNR commits to implementing the 2006 Lynx Plan until lynx are delisted or until 2076, whichever is shorter (WADNR 2006, p. 6). Thus, it appears the regulatory future of lynx management, and thus, lynx habitat management, is largely secure on both federal and state managed lands within Washington State.

Climate Warming - The one risk factor identified by the LCAS over which the Forest Service, or the WADNR for that matter, has little ability to control or influence is climate change. Climate change was identified by the panel of lynx experts convened during development of the Canada Lynx Expert Elicitation Workshop Report to potentially represent the greatest threat to the long-term persistence of lynx (Lynx Workshop Report 2016, p. 56).

Potentially further exacerbating the recent losses of lynx habitat from fires is climate change. Climate change may affect fire return intervals and severity as well as the quality and depth of snow within lynx habitat. Westerling *et al.* (2006, pp. 942-943) compiled information on large wildfires in the western U.S. from 1970-2004 and found that large wildfire activity has increased significantly from the mid-1980s with large-wildfire frequency, longer wildfire duration, and longer wildfire seasons. The greatest increases occurred in high elevation forest types including lodgepole pine and spruce fir in the northern Rockies (i.e., lynx habitat). They also found that fire exclusion had little impact on natural fire regimes. Rather, climate appeared to be the primary driver of increasing wildfire risk. As stated previously, Koehler's (1990, p. 847) estimated adult lynx density of 2.3 lynx/100 km^2 was obtained in an area supporting high quality lynx habitat in the Meadows area of north central Washington (at least relative to other lynx habitat in Washington). Much of the lynx habitat in the Meadows was impacted by the recent large, stand replacing fires in the Cascades, resulting in further fragmentation of lynx habitat in the northern Cascades. Thus, the lynx densities Koehler observed in his study area may not be

currently supported, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines.

Additionally, relative to the persistence of Washington's lynx population, during the lynx expert elicitation workshop several of the lynx experts expressed concern that should more wildfires occur within the next 10 years and result in losses of lynx habitat similar to the impacts caused by the recent wildfires, such wildfires could result in the functional extirpation of lynx in Washington. The experts expressed heightened concern of functional extirpation of lynx in this geographic unit from wildfires due to its small size and current lynx population (Lynx Workshop Report 2016, p. 27). However, the experts felt the potential extirpation of lynx, should it occur from a large catastrophic wildfire(s) (or other mechanisms such as insect outbreaks), may be ameliorated to some extent due to Washington's juxtaposition and connectivity to Canadian lynx populations. The experts felt that lynx immigration from Canada may rapidly recolonize Washington as the habitat recovers from fires or other impacts (Lynx Workshop Report 2016, p. 43). Climate change, in addition to potentially affecting fire return intervals, fire severity (intensity, size), and insect outbreaks, is likely to affect the amount of precipitation falling as snow at elevations typically supporting lynx habitat in this geographic unit.

Lynx survive in areas with cold, snowy winters providing deep, fluffy snow (78 FR 59443) that gives lynx competitive advantages over other competitors and predators of lynx, as well as providing the conditions supporting the lynx's main prey, the snowshoe hare, which can comprise as much as 97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448).

Climate change may impact the quantity, quality, and temporality of snow in the Cascades. Mote (2003, pp. 272, 274), who evaluated temperature trends in the Pacific Northwest using data collected by weather stations from 1930 to 1995, determined that the temperature increased in the Pacific Northwest, and more precipitation fell in the spring and summer months, especially at elevations below 1,800 m (5,900 ft). Additionally, Mote (2003, pp. 2-3) determined that an increasing temperature and precipitation trend from 1950 to 2000 is correlated with a 40 percent decrease in the snow water equivalent in the Cascades. Mote *et al.* (2005, p.45) determined that the Cascades are very sensitive to temperature changes, with large increases in temperature potentially resulting in significant declines in snowpack. Corroborating Mote's speculation, Stoelinga *et al.* (2010, p. 2474) determined that the Cascade snowpack has declined by up to 40 percent in the latter half of the twentieth century, which resulted from increased temperatures. Furthermore, predicted continued increasing temperature changes of 2° C to 5° C over the next century are expected to cause further and accelerated losses in snowpack in the Cascades (Mote *et al.* 2005, p. 48). Continued declines of snowpack in the Cascades through 2025 are predicted to range from 9 percent (Stoelinga *et al.* 2010, p. 2486) to 29 percent (Elsner *et al.* 2010 *cited in* Stoelinga *et al.* 2010, p. 2486), which may also affect lynx densities supported in the Cascades. Finally, some of the best lynx habitat in this geographic unit occurs on plateaus that may be more vulnerable to impacts of climate change because of the absence of higher elevation areas to which habitats and lynx could migrate in response to climate warming (Lynx Workshop Report 2016, p. 42). Thus, in addition to the recent losses of

lynx habitat to large wildfires, coupled with increasing wildfire risk, the potential for the Cascades to support a viable lynx population may be further reduced due to decreasing quantity and quality of snow.

Similar to the potential effects of wildfires on the persistence of the lynx population in this geographic unit, the lynx experts identified climate change relating to loss of favorable snow conditions as a significant factor potentially affecting the long-term persistence of this population (Lynx Workshop Report 2016, pp. 43-44). Taking all factors into consideration (i.e., catastrophic wildfire, insect outbreaks, loss of snow), the experts felt the probability of this population persisting to the year 2050 most likely ranged between approximately 60 percent to 80 percent, declining by the year 2100 to approximately 30 percent to 50 percent (Lynx Workshop Report 2016, p. 43).

5.2.5 Unit 5 - Greater Yellowstone Area

Expert Projections of Future Lynx Status

The expert graphs for this unit were widely variable and had different outcomes and high uncertainty at all time frames. Experts predicted near-term (year 2025) persistence probabilities of 10% to 70% (median = 52%), and mid-century persistence at 15% to 60% (median = 35%). All experts predicted end-of-century persistence probabilities less than 50% for this unit, with a median of 15%, by 2100 (Figure 12). This was the only unit for which most experts believed the present probability of persistence is low (i.e., that it is uncertain whether this area currently supports a resident lynx population). Some experts increased probability of persistence into mid-century as the 1980s-era fires regenerate into hare/lynx habitat, and with the poss bility of continued immigration of lynx from Colorado. Other experts project a 10% to 20% probability of persistence by 2100. One reason given for wide variability in responses is because of the uncertainty whether a population currently exists. There were wide confidence intervals around the probabilities for all time periods for this area.

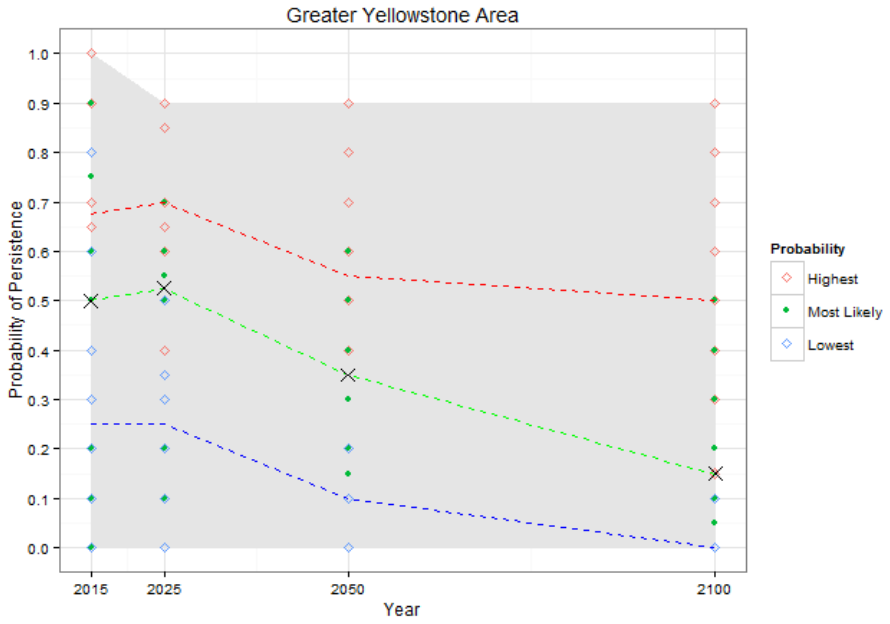


Figure 12. Lynx expert estimates of the probability that the Greater Yellowstone Area Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Current and future factors expressed by experts as influencing probability of persistence for this unit included small population size, forest disease and insect pests, and fire. Some experts doubt that the GYA unit currently supports a resident breeding population of lynx. Experts indicated that climate models predict that some parts of the GYA unit could provide refuge from climate change impacts because of their high elevations and potential to maintain winter snow levels into the future. Summer conditions in this unit, however, could be drier in the future, resulting in increased fire frequency, extent and intensity, and additional temporary habitat loss. However, regeneration of these areas and the extensive areas that have burned in the recent past may provide good habitat over the next several decades. Lynx immigrating to this unit from Colorado could occupy such improved habitats in the near future. Colorado lynx have made exploratory movements into the GYA in summer months, and analysis of available data could improve our understanding of Colorado lynx movement into and use of the GYA. It is possible that lynx from Colorado are maintaining or could maintain lynx in GYA.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - As noted above in section 5.2.3, federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Federal lands account for over 97 percent of this geographic unit; therefore, regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations. Also as described above, revisions or amendments to federal management plans require opportunities for public participation in accordance with NEPA, NFMA, National Parks and Recreation Act, and FLPMA (USFWS 2014 pp. 26-34; also see 3.1, above) and consultation with the Service in accordance with section 7 of the ESA. If the DPS were to be recovered and delisted in the future, the ESA requires a minimum of five years of monitoring to assess its ability to sustain itself without the ESA's protective measures. If, during that time, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (USFS 2007, Attachment 1, p. 2; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore potential lynx habitats in this geographic unit in the future.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support

conservation and restoration of lynx habitats in this unit and improve the likelihood that it will support resident lynx into the future. Because non-federal lands make up such a small proportion of this geographic unit, we believe it is unlikely that regulatory mechanisms on those lands will influence this unit's future ability to support resident lynx.

If the DPS were to be delisted in the future, State-managed trapping could resume in this geographic unit. We expect that would occur only if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.5, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 46). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely further compromising this unit's ability to support resident lynx populations, which is already questionable.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, including the extensive fires in Yellowstone National Park in 1988, which burned over one-third of the park. Climate warming has also been linked to increased frequency

and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of landscapes in the GYA to support resident lynx may be further compromised, and resident lynx may be unable to persist until favorable vegetation conditions return. This is especially true where potential habitats are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced by intermittent immigration from the north, and if climate change diminishes the l kelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will further reduce this geographic unit's ability to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx and habitats in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears l kely that continued climate warming will further reduce habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.5, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.5, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although the extent to which increased wildfire activity has impacted this unit's current ability to support resident lynx is uncertain, such impacts may become more likely in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand- initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support resident lynx until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.5, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – This geographic unit is not directly connected to lynx populations in Canada or elsewhere in the DPS range, although lynx released into Colorado have dispersed northward into and through this unit. There is little evidence of intermittent

immigration into this unit during past irruptions of lynx from Canada, as has been documented in other parts of the contiguous U.S. Nonetheless, as elsewhere in the DPS, immigration may influence the persistence of resident lynx in this unit. If continued climate warming or other factors further reduce the chances that dispersing lynx will reach this unit and contribute to its demographic and genetic health, either through habitat loss and fragmentation in potential dispersal corridors or declines in the amplitude of northern hare and lynx population cycles, the likelihood that the unit will support resident lynx in the future may also decline. However, as in Unit 3 above, because we lack information of historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.6 Unit 6 - Western Colorado

Expert Projections of Future Lynx Status

The majority of the experts suggested an initially high probability of persistence in Colorado, declining gradually with increasing uncertainty through the end of the century. Experts predicted near-term (year 2025) persistence probabilities of 60 percent to 100 percent (median = 90 percent), and mid-century persistence at 50 percent to 85 percent (median = 80 percent). Experts predicted end-of-century persistence probabilities of 20 percent to 70 percent for this unit, with a median of 50 percent, by 2100 (Figure 13).

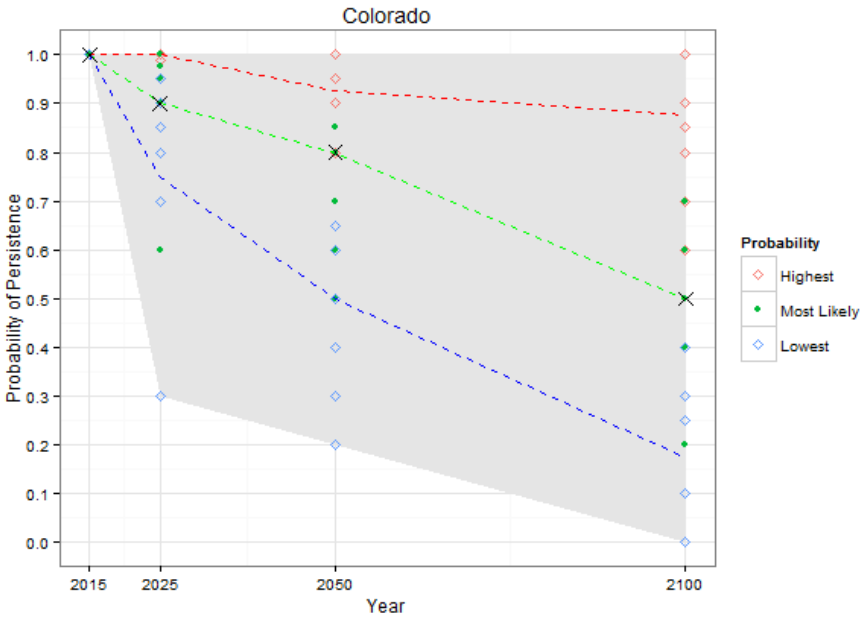


Figure 13. Expected probability of persistence for the Western Colorado Geographic Unit at present, 2015, and in 2025, 2050 and 2100.

Some experts indicated that beetle kill and fire could potentially create poor habitat conditions in large areas of this unit by mid-century, but that regeneration after these impacts could result in good lynx/hare habitats. Others expressed uncertainty about whether fire and insect impacts would be temporary or permanent, especially considering climate change and the potential for conversion from boreal/subalpine forests to other forest types. Although 8 of 10 experts graphed 50 percent to 70 percent probability of persistence at 2100, during subsequent discussions, several expressed greater uncertainty about whether resident lynx will persist in the unit at the end of the century. Higher-quality lynx habitat occurs primarily in two areas and is patchily-distributed. Lynx in this unit may occur as several smaller, relatively isolated subpopulations, which are likely more vulnerable to stochastic events. This unit's relative isolation may limit exchange with other lynx populations, increasing the likelihood of genetic drift and reducing the chance of demographic rescue or recolonization if lynx in the unit become extirpated. There was discussion about whether ski areas may affect daily movements of lynx, and hares may be declining in ski areas. Ski areas tend to expand and may, therefore, have larger impacts on lynx in future. There is some evidence of lynx using ski areas in summer months but avoiding them during the ski season. It is uncertain whether ski areas may affect genetic connectivity within the Western Colorado geographic unit. Two-thirds to three-quarters of the lynx in this unit are in the southern portion of the range in the San Juan Mountains. There is a large area (Weminuche

Wilderness) in Colorado that has not been well surveyed for lynx, so it is possible that lynx also could be using that area.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - Regulatory mechanisms for the conservation of lynx in the Southern Rockies consist of seven amended USFS management plans in south-central Wyoming, and Colorado. We concluded that the Southern Rockies Lynx Amendment substantively reduced the inadequate regulatory mechanisms by addressing the major adverse impacts of Forest Service land management on lynx (Service 2008, p 70-71). Lynx habitat on all other ownerships makes up the remaining 15 percent of lynx habitat in Colorado, of which, only five percent is in federal ownership. Other ownerships include state, county, municipal, etc., and private lands. The BLM resource management plans have not been amended to include conservation specifically for lynx and, with a few exceptions. Lynx habitat on BLM ownership mostly consists of narrow forest extensions connected to larger blocks of habitat on adjacent USFS lands. Generally these extensions are insufficient on their own to support a lynx home range. However, the Gunnison Field Office is the only BLM unit that contains sufficient habitat to map and identify LAUs.

The State of Colorado manages lynx as a state endangered species C.R.S. 33-2-105, prohibiting take of the species with exceptions for protection of human life (C.R.S. 33-6-205 and incidentally during depredation management (not caused by lynx) [C.R.S. 33-6-207].

Climate Change - ILBT (2013 p. 61) – “Climate change generally is expected to result in warmer winters, earlier spring snowmelt, and a reduction in the extent of snow cover in the southern Rockies. McKelvey *et al.* (2011 entire in ILBT 2013) used a variety of climate models to predict snow depth and the persistence of spring snow across the western United States. The models predicted an overall decline in persistent snow of 40 percent, but large areas of persistent snow would continue to be retained late in the 21st century, including the high elevations of Colorado.”

“All of the climate models under all representative concentration pathway (RCP) project that Colorado’s climate will warm substantially by 2050. Under RCP 4.5 (medium-low emissions scenario), Colorado’s annual temperatures are projected to warm by +2.5°F to +5°F by mid-century relative to 1971–2000 observed baseline. Under RCP 8.5 (high emissions scenario), Colorado’s annual temperatures are projected to warm by +3.5°F to +6.5°F by mid-century. Summers are projected to warm slightly more than winters under both RCPs. Looking beyond the 2050-centered analysis period, the warming trend is projected to continue into the late-21st century under all RCPs except RCP 2.6. By the period centered on 2070 (2055–2084), the projected warming in Colorado annual temperatures under RCP 4.5 is +2.5°F to +6.5°F relative to the 1971–2000 baseline. Under RCP 8.5, the projected warming is +5.5°F to +9.5°F relative to the 1971–2000 baseline.” [Lukas *et al.* 2014 page 61]

An analysis of projected 21st century temperature trends as a function of elevation in the Northern Hemisphere mid-latitudes from CMIP5 models shows more warming at higher

elevations during winter, particularly in the daily minimum temperature (Rangwala *et al.* 2013 [cited in Lukas *et al.* 2014 page 63]). “However, as discussed in Section 3, the global climate models do not represent the topography of Colorado very well, so it is difficult to discern whether the warming projected for the higher elevation regions (>10,000’) in the state is substantially different from that projected for lower elevations” (Lukas *et al.* 2014 page 63).

On average, the climate models indicate a seasonal shift in precipitation for Colorado, with increasing winter precipitation, and in some areas a decrease in late spring precipitation (Lukas *et al.* 2014, page 65).

Vegetation Management - In the past decade, vegetation management within lynx habitat has been predominantly salvage of dead and dying timber caused by a mountain pine beetle infestation in the northern part of the state (generally north of Interstate 70), and a spruce bark beetle infestation south of the interstate. Salvage operations may temporarily impact understory regeneration, if present, reducing the capacity of the stand to support higher snowshoe hare densities. Assuming the existing US Forest Service plans retain their current conservation framework, USFS lands should continue to provide sufficient habitat for lynx through the end of the century.

Vegetation management on non-federal ownerships within lynx habitat is unlikely to cause significant concern for lynx conservation in Colorado through the remainder of the century.

Wildland Fire Management - “It is generally acknowledged that in the Southern Rocky Mountains fire suppression has altered historic vegetative patterns. This effect has been most pronounced within vegetation communities where fire regimes are of low intensity or mixed severity. It is generally agreed that spruce-fir habitats have been little affected by fire suppression because the fire regimes within this type tend to be stand-replacing events occurring at long intervals (100+ years). Depending on the moisture regime, large stand-replacing fires within lynx habitat may produce young age class snowshoe hare habitat after approximately 10-30 years. Although this vegetative condition may provide some high quality snowshoe hare habitat, mature forests are also very important as winter foraging habitat.” (USFS 2008 page 36)

Habitat Fragmentation - Sources of current habitat fragmentation include high-speed high-volume highways, high mountain valley developments, vegetation management, ski/recreation area development, and wildland fire. Currently, only vegetation management on USFS lands is managed to limit lynx habitat fragmentation. Highways are likely to be expanded to accommodate increasing traffic volume as mountain valley communities continue to be developed and expended. While these linear features already exist on the landscape, widening of the cleared right-of-way, as well as behavioral avoidance of highway rights-of-way due to traffic reduces available habitat. Many ski areas in Colorado are located within lynx habitat and will likely be expanded in the future through permanent removal of vegetation to create conventional ski runs, reducing tree density and clearing understory vegetation to create glade conditions, reduces lynx habitat. The magnitude of fragmentation caused by these sources of

has not been quantified, but is unlikely to remove enough habitat to eliminate the possibility of lynx persistence in Colorado.

Chapter 6: Synthesis

This section synthesizes the needs, current condition, and likely future condition of the Canada lynx in the contiguous U.S. DPS with respect to the conservation biology principles of representation, redundancy, and resiliency. Its purpose is to provide an understanding of the range-wide status of this DPS that is as clear as possible given the unavoidable uncertainties involving demography and long-term threats.

Needs

Throughout the species' range, the lynx is a habitat and prey specialist requiring boreal forests with dense horizontal cover, long winters, and deep, fluffy snow, which gives it a competitive advantage for exploiting its primary prey, the snowshoe hare. Lynx in the contiguous U.S. have ecological requirements similar to those of lynx in Canada and Alaska, and throughout the species' range hare abundance is the primary driver of lynx population dynamics. However, the DPS is at the southernmost margin of the species' range, where boreal forests transition to temperate conifer and hardwood forests, and where snow conditions and hare abundance generally become less favorable with decreasing latitude. Because of this, habitat is less extensive and generally more fragmented within the DPS range than in the core of the species' range in Canada and Alaska. As a result, lynx in the contiguous U.S. are naturally less abundant and more patchily distributed than in the core of the range. Maintaining connectivity between lynx populations in Canada and the DPS is thought to be important; however, whether and if so to what extent the demographic and/or genetic health of DPS populations relies on periodic immigration from Canadian populations remains uncertain.

Current Conditions and Threats

Resiliency, the ability to withstand stochastic disturbance events, and redundancy, the ability to withstand catastrophic events, are currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. Available information indicates that five out of six geographic units in the DPS contain resident breeding lynx populations. Although we have no reliable population-size estimates for any of the geographic units, Northern Maine (Unit 1) is believed to currently support the largest resident population in the DPS. In Northeastern Minnesota (Unit 2), a resident population occupies the Arrowhead Region of the State. Northwestern Montana and northeastern Idaho (Unit 3) continue to support resident lynx, although a small subpopulation in the Garnet Mountains on the southern periphery of this unit may have been extirpated recently. In North-central Washington (Unit 4), recent extensive wildfires have temporarily reduced the amount of high-quality lynx habitat and may have caused a decline in lynx numbers there. Since the release of Canadian and Alaskan lynx in 1999-2006, resident lynx currently occupy western Colorado (Unit 6). The Greater Yellowstone Area (GYA, Unit 5) is thought to have historically supported a small

resident population; however, resident lynx have not been documented recently in this unit. The apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distr bution and relative abundance of resident lynx are substantially reduced from historic conditions suggest the historical and recent resiliency of lynx populations in the DPS. The large sizes and broad geographic distributions of the areas occupied by resident lynx populations likewise indicate adequate historical and current redundancy in the DPS to preclude its extirpation because of catastrophic events.

Representation, the ability of a species to adapt to changing environmental conditions over time, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Information provided by lynx experts and geneticists indicates high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Hybridization with bobcats has been documented but is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Thus, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions.

The primary threat identified at the time of listing, lack of regulations protecting lynx habitat on federal lands, has been largely addressed by formal and binding amendments or revisions to most federal land management plans within the DPS range. Although questions remain about the efficacy of this improved regulatory framework, federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands. Most federal lands, which constitute 64 percent of lynx habitat evaluated in this SSA, are found in the western U.S.

Other stressors affect lynx in one or more geographic units. For example, in northern Maine, where most high-quality lynx habitat occurs on private commercial timber lands and is the result of past timber harvest, changes in State forestry regulations (the Maine Forest Practices Act of 1989) that govern private forest management may currently be causing decreases in habitat quantity, quality, and distribution, and in lynx numbers (also see *Future Conditions and Threats*, below). The lack of binding lynx conservation commitments on private lands may exacerbate this risk to current lynx habitats in Maine. In North-central Washington, recent large-scale wildfires have resulted in the temporary loss of nearly 50 percent of lynx habitat, likely reducing this unit's current lynx population and potentially compromising its current ability to support a

resident population until habitats recover. Increased wildfire activity also has impacted lynx habitats in the other western geographic units (Northwestern Montana/Northeastern Idaho, the GYA, and Western Colorado), but the extent to which it has influenced the current condition of lynx populations in those units is uncertain.

Climate change is occurring at a global and, thus, a DPS-wide scale. Climate warming has reduced snow amount, duration, and quality (in terms of conditions favorable for lynx), it has been linked to increased frequency, size, and severity of wildfires and forest insect outbreaks, and it likely has already resulted in some changes in forest vegetative communities. Climate warming has also been linked to changes in the amplitude, periodicity, and synchronicity of northern hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in the DPS depend on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and an increased likelihood of extirpation among resident populations would be expected. However, whether, and if so to what extent, these climate-mediated factors have influenced current lynx numbers, other demographic parameters, and/or habitat quality and distribution is uncertain and has not been quantified across the range of the DPS or in individual geographic units. Despite uncertainty regarding its influence over current conditions for lynx, climate modeling and expert opinion concur that continued climate warming will adversely impact lynx in the DPS in the future (see below).

Future Conditions and Threats

Overall, expert opinion and our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). Forest management on private lands that lack lynx conservation commitments may also contribute to future declines, particularly in northern Maine. In each geographic unit, the probability that resident lynx populations will persist is expected to decline. The loss of resident lynx from one or more geographic unit would represent reduced future resiliency, redundancy, and representation within the lynx DPS.

The resiliency of lynx populations in individual geographic units is the primary determinant of the future viability of the lynx DPS. Expert opinion and our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing,

extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are l kely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible to stochastic events.

The loss of any geographic units would also reduce the level of redundancy and could diminish representation within the DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation of one or more of the individual geographic units (e.g., fires in north-central Washington, as described above), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and l kely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Furthermore, based on expert input, there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS. How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and l kely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Given the high percentage of federal land ownership in the West, regulatory commitments that these lands will continue to be managed in accordance with lynx conservation principles, and

the existence of potential high-elevation climate refugia to which lynx habitats and some lynx might move, the western geographic units (Units 3-6) may be more l kely to support resident lynx longer under projected continued climate warming. Nonetheless, it is unlikely that any management actions can abate the long-term retreat of boreal forests and diminished snow conditions projected by climate models. Further, the size, frequency, and intensity of wildfires and forest insect outbreaks are expected to increase with continued climate warming, particularly in the western portion of the DPS, although we do not anticipate such events in-and-of-themselves are likely to cause the permanent loss of breeding lynx populations in any geographic unit.

Although projections of climate-mediated losses of boreal forests and favorable snow conditions suggest impacts to lynx and hare populations throughout the DPS, persistence of resident lynx in Maine and Minnesota may be relatively lower than the western geographic units given the smaller percent of federal lands and the absence of associated regulatory commitments to lynx conservation, and the lack of potential elevational refugia. Additionally, as noted above, changes to regulations governing timber harvest on private forest lands in Maine are unlikely to maintain the current historically-high amount and distribution of good lynx habitat or the current large population of resident lynx. These changes, which may affect over 90 percent of lynx habitats in northern Maine, are projected to result in substantial declines in habitat quality and distribution, and lynx numbers, over the next 10-30 years, primarily through restrictions on clearcutting and the proliferation of partial harvesting, which are detrimental to snowshoe hare and lynx needs. On private forest lands, energy development (wind energy, mining), rapid turnover in ownership and parcelization of forest land, and uncertain forest markets may also reduce the future quality and quantity of lynx habitat.

DPS viability

Although all five geographic units that currently support populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more l kely than not) by the end of the century (Lynx SSA Team 2016, pp. 36-49, 58). All other geographic units have a 50 percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century, with a moderate to high likelihood that resident lynx will be lost from two to four units by then. Potential elevational refugia may increase the likelihood of persistence in western units, although uncertainty remains about the timing of warming-driven upslope movements of habitats and snow conditions and the extent to which hare and lynx populations may follow them. Regardless, future lynx habitats throughout the DPS range are likely to be smaller and more fragmented, and geographic units that are already relatively isolated from other lynx populations are likely to become even more isolated in the future. Despite the lack of elevational refugia, lynx may also persist at the end of the century in Maine and Minnesota, depending on the timing and severity of climate change effects and, in Maine, on trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in

concert with input from lynx experts suggests that the probability of the persistence of resident breeding populations will decline in all geographic units beginning as early as 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the potential functional extirpation of resident lynx populations from one or more geographic unit would demonstrate a loss of resiliency, reduced redundancy, and, possibly, reduced representation within the DPS. These losses in resiliency, redundancy, and representation will put the Canada lynx DPS at increasing risk of extirpation through the end of this century.

Commented [MJM32]: It actually starts now. All species have decreasing probability of persistence over time. That probability never stays the same or increases.

Species Status Assessment

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment



Photo by Keith Williams

Version 2.0 - Draft
~~September~~ October 2016

U.S. Fish and Wildlife Service
Regions 1, 3, 5 and 6

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Executive Summary

Background

This report presents the results of a species status assessment (SSA) conducted for the contiguous United States distinct population segment (DPS) of Canada lynx (*Lynx canadensis*). The DPS was listed in 2000 as threatened under the Endangered Species Act (ESA) because of the inadequacy of regulatory mechanisms on federal lands. The SSA will provide the scientific basis for the statutorily required 5-year status review for this listed species and other decisions the Service is required to make in accordance with the ESA. The SSA provides an evaluation of the current and future status of lynx in six geographic units within the DPS that currently support or recently supported resident breeding populations. The units are distributed across the northern contiguous U.S. from Maine to Washington and south along the Rocky Mountains to western Colorado. These geographic units combined represent approximately the southern two percent of the species' entire breeding range (ninety-eight percent occurs in Canada and Alaska). The units are relatively isolated from each other, although four of the six units are directly connected to lynx populations and habitats in Canada. These SSA geographic units are:

Unit No.	Name	Size (km^2)
Unit 1	Northern Maine	28,909
Unit 2	Northeastern Minnesota	21,101
Unit 3	Northwestern Montana/Northeastern Idaho	26,997
Unit 4	North-central Washington	5,176
Unit 5	Greater Yellowstone Area	23,687
Unit 6	Western Colorado	25,294

The SSA relied on both the available scientific literature and the professional judgments and opinions of recognized lynx experts to (1) describe the ecological requirements and population dynamics of the species, (2) evaluate the historical and current status of lynx populations in the six geographic units and the factors that appear to have influenced these populations, and (3) assess the likely future viability of the DPS through the end of the century in terms of representation, redundancy, and resiliency (the "3 Rs").

Lynx are habitat and prey specialists and require boreal forests having long winters with deep, fluffy snow. These conditions provide lynx with a competitive advantage over other predators for exploiting their primary prey, the snowshoe hare. Lynx habitat and, thus, lynx are naturally less abundant and more patchily distributed in the DPS than in the core of the species' range in Canada and Alaska. This is because the DPS occurs at the southernmost margin of the

Comment [MJM1]: This comes across too much as "deferring" to expert opinion. We need to "own" the conclusions. We need to make it clear hat "our" assessment was informed by the experts' opinions – that we didn't automatically accept the expert's opinions. We need to explain the reasons behind the experts' opinions, explain why we agree or disagree, and then state the conclusions as our own.

Comment [MJM2]: The document sometimes uses historic and sometimes historical. Recommend being consistent. Recommend "historical" to avoid confusion with he "momentous" meaning of "historic."

Comment [MJM3]: The purpose of the SSA should be to assess the full risk profile of the species, not just its "likely" future. The viability of the species should be a descrip ion of the risk to its persistence, which may be influenced by possible future scenarios that are less than likely.

species' range and of the environmental thresholds of snow quality, depth, and persistence; hare density; and boreal forest conditions that lynx require. Maintaining connectivity between the DPS and lynx populations in Canada is thought to be important, but whether DPS populations rely on intermittent immigration of lynx from Canada, and, if so, to what extent, remain uncertain.

Research and surveys undertaken since the listing of the DPS in 2000 have significantly improved our knowledge of the distribution, habitats, and population status of resident breeding lynx populations. For example, although we knew there were resident lynx in Maine, we did not have an understanding of population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS; we also understand that past timber management has created the current abundance of high-quality lynx habitat, and we believe that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain as to whether Minnesota supported a resident breeding population, but we now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. are naturally less abundant and more patchily distributed than was thought at the time of listing, and lynx may have been recently extirpated from several areas thought to have previously supported small resident populations (the Kettle Mountains in northeastern Washington, the Garnet Mountains in western Montana, and the Greater Yellowstone Area). We also know that recent extensive wildfires in north-central Washington have temporarily reduced the amount of high-quality lynx habitat and have probably caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999 to 2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado.

Comment [MJM4]: To dis inguish from regulatory status as E or T.

SSA Framework

The framework for conducting an SSA takes into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time. Relative to the ecological requirements of the lynx within the DPS, we assessed current conditions at the individual, population, and range-wide levels, and the likely changes in the environment that may influence the future condition of individuals, populations, and the DPS and thus the viability of the DPS.

Comment [MJM5]: The contribution to risk from less-than-likely changes to he environment also need to be assessed.

The SSA uses the conservation biology principles of representation, redundancy, and resiliency (the "3 Rs") as the framework for assessing current and future conditions. Resiliency describes the ability of the species to withstand stochasticity, redundancy describes the ability of the species to withstand catastrophic events, and representation describes the ability of the species to adapt over time to long-term changes in the environment. The 3 Rs can be influenced by any number of factors. For the lynx, these factors included the original reason for listing the lynx DPS as threatened: inadequacy of regulatory mechanisms. Other factors included climate change, vegetation management, wildfires, and habitat connectivity

SSA Assumptions and Uncertainties

A fundamental hypothesis underlying the SSA is that the ability of lynx to persist in the DPS is a function of metapopulation dynamics with Canada, i.e., the DPS is infused intermittently with lynx from Canada following high hare cycles.

Overall, uncertainties abound with regard to lynx demography and effects of various stressors on DPS populations. The primary sources of uncertainty for this analysis include a lack of empirical data regarding population sizes and trends, the extent of immigration of lynx from Canada ~~to the persistence of U. S. populations~~, trends in hare populations, and effects of habitat management on lynx. Most importantly given the importance of climate change as a stressor, we lack information on the pace and extent of changes in snow quality, depth, and persistence and how ~~this~~these changes affect~~s~~ the relationship between lynx and their competitors.

For purposes of the SSA, we forecasted potential effects and trends through the end of this century. This time frame is based on the level of uncertainty about climate change and other effects on lynx populations; it is also a long enough time frame to detect lynx population trends across the DPS.

Current Conditions

Currently, ~~four~~ of the six DPS units, four (Northern Maine, Minnesota, Northwestern Montana, and Western Colorado) demonstrate high levels of resiliency. The North-central Washington Unit (Unit 4) was also considered resilient until recent wildfires consumed an extensive amount of habitat, likely resulting in a diminished population that may be susceptible to stochastic events. The Greater Yellowstone area historically supported resident lynx, but it is unclear whether the area still supports a breeding population due to the distance and relative isolation of the unit from Canada as well as the less than favorable habitat conditions and snowshoe hare densities.

As shown in the table above, five of the six units are larger than 20,000 km^2; the other is over 5,000 km^2. Land ownership within the units varies from mostly private in Maine, to a mix of private, State, and ~~f~~Federal lands in Minnesota, to mostly ~~f~~Federal lands in the West. Overall, ~~f~~Federal lands account for nearly 64 percent of the areas encompassed by the SSA units. Of non-~~f~~Federal areas, private lands make up almost 27 percent of the total followed by State and Tribal lands. Available data indicate that distribution within the DPS remains similar to historical patterns and that the number of units across the DPS has not been meaningfully diminished from historical levels, given the uncertainty about the past occupancy of the Greater Yellowstone area by a resident breeding lynx population.

Given the resiliency of most geographic units and the ~~improbability~~ low likelihood that a~~ny imminent~~ catastrophic event will cause the extirpation of an entire unit or, especially, the DPS as a whole in the near term, redundancy is not currently a~~n~~ issue for the lynx DPS. Also, because

Comment [MJM6]: This doesn't make sense in this phrase.

Comment [MJM7]: This is inconsistently referred to as Northwestern Montana and Northwestern Montana/Northeastern Idaho. Recommend being consistent.

Comment [MJM8]: Resiliency relates to the ability to withstand stochas icity. How is it a factor in drawing this conclusion about redundancy?

Comment [MJM9]: This seems to be saying we know of at least one catastrophic event hat will happen soon but won't cause extirpation. This is at odds with our definition of a catastrophic event as an event that would or has high potential to cause extirpation. Because he kinds of catastrophic events we typically deal with are unpredictable, we can't say a catastrophic event is imminent unless it's already started. A catastrophic event has a low likelihood of occurring within a short period of ime and a higher likelihood over a longer period of time. I think what we're trying to say is simply hat a catastrophic event is not likely to happen in the near term.

Comment [MJM10]: I was confused by this wording. We're in the business of assessing risk over decades into he future, so a factor hat affects that long-term risk would be an issue for us to evaluate now and therefore would be curren ly an issue. I think what we're trying to say is that it is "not an issue for the near-term persistence of the DPS."

lynx are genetically similar throughout the entire range of the species, and because we did not find any diminishment of adaptability and evolutionary capacity of DPS populations based on the known historical record, we do not consider representation to be a current issue for lynx.

The original reason for which the DPS was listed, inadequacy of regulatory mechanisms, has been largely ameliorated on public lands within the western geographic units. Climate change, vegetation management, wildfires, and habitat fragmentation are now stressors of more heightened concern. We know that wildfires are causing depletion of lynx in some areas in the West, particularly in the North-~~C~~central Washington Unit. We also know that past vegetation management in the ~~n~~Northern Maine Unit has resulted in a lynx population that is currently the largest in the DPS. Conversely, stressors such as climate change and associated habitat alterations, while currently occurring, may not demonstrate demographic effects on lynx within the next decade.

Future Conditions

Resiliency of individual geographic units, which function independently of each other, is the primary determinant of future lynx DPS viability. Overall, our analysis indicates a ~~reduced~~decreasing probability of persistence for ~~all~~each geographic unit~~s~~ within the DPS over the rest of the century (noting that the analysis did not extend beyond that 2100 time frame). It further indicates a consequent permanent loss of two to four of the six units, i.e., loss of resiliency, by the end of the century.

Representation and redundancy are lesser factors for DPS viability~~,~~ for several reasons. Although the populations in the DPS units are demographically isolated from each other, there is little risk of significant genetic drift within the DPS, likely due to most areas being relatively well connected with Canadian populations; this is indicative of relative genetic health through the end of the century. Furthermore, based on expert input, there is no indication that the relatively low level of genetic diversity is likely to reduce DPS viability in the future (USFWS 2016, p. 51). Because of the ability of lynx to widely disperse, and because it is unlikely that insurmountable barriers to lynx dispersal between Canada and the DPS will emerge, we do not expect representation to become a concern through the turn of the century.

With regard to redundancy, neither the scientific literature nor expert input provide a basis for concluding that any catastrophic event could cause extirpation of any one geographic unit. It is even ess likey that a single catastrophic event will eliminate all populations in the DPS. It is important to note, however, that a sequence of less-than-catastrophic events could result in extirpat~~e~~ion of one or more ~~individual~~ units over time, thereby reducing redundancy within the DPS.

The likelihood of persistence of individual populations, and thus geographic units, is expected to decrease by 2100 primarily because of climate change effects on snow conditions and boreal forests. The other long-term threat is forest management practices that are not conducive to landscape hare densities able to support lynx, although this stressor may be limited to one geographic unit. Threats affecting the future condition of the DPS are summarized below.

Comment [MJM11]: See comment above.

Comment [MJM12]: By itself, this sounds like a good thing. Explain how this is a "heightened concern."

Comment [MJM13]: Is this the imeframe that defines current condition? If not, say instead something like "may not cause demographic effects for a decade or more."

Comment [MJM14]: Reduced from what?

This is a meaningless statement. Every species has a decreasing probability of persistence with increasing time. Describe the decrease in terms of its magnitude and significance.

Comment [MJM15]: Is this change correct? Or are you trying to say one or more units have increasing probabilities but the DPS as a whole has a decreasing probability?

Comment [MJM16]: Wouldn't loss of populations be a loss of redundancy, not resiliency? The loss of a population is a loss of redundancy; the means by which a population is lost is the decrease in resilience over ime that leads to the ultimate outcome of loss of the population.

Comment [MJM17]: I assume this is based on he "most likely" future scenario. What is he risk of loss of more than two to four units? We need to know the full risk profile.

Comment [MJM18]: But is there a meaningful risk?

Comment [MJM19]: But is there a meaningful risk?

Comment [MJM20]: "Could" simply means "possible" and is ambiguous. Would be better to say there is "no meaningful risk" of a catastrophic event causing extirpa ion of any one unit.

Comment [MJM21]: The odds of all of several events happening is always less than he odds of any single event happening. Describe this risk in more absolute terms rather han in terms of a meaningless comparison.

Comment [MJM22]: I read his as referring to a sequence of catastrophic events, each one causing ex irpation of a unit. Made this change to avoid that interpretation.

Comment [MJM23]: Isn't this statement saying the same hing as the last sentence in he first paragraph of this section? This sentence says the loss of popula ions "could" occur; the sentence in the first paragraph describes this as predicted to happen. Recommend being more precise.

Comment [MJM24]: This is a meaningless statement. Every species has a decreasing likelihood of persistence over time. What we're talking about here is our prediction of a decrease of a certain magnitude that is due to certain factors. Recast the sentence to something like "The predicted decrease in th...

Based on climate change models, the effects of climate change on snow and boreal forest conditions are foreseen as the primary stressor limiting future viability of lynx in the DPS. The southernmost boreal habitats are predicted to retreat northward and upslope, fragmenting and diminishing the quality of lynx and hare habitat within the DPS (although some uncertainty remains regarding the timing, extent, and biological consequences of such impacts). As habitat conditions decline, mortality rates are likely to increase and reproductive rates decrease. This in turn will reduce abundance and density of individuals within populations, making lynx populations more susceptible to stochastic events.

Given the percent of ~~f~~Federal land ownership, ~~-~~regulatory assurances that these lands will be managed in accordance with lynx conservation, and a stronger possibility that lynx populations will be able to relocate to higher elevations, western geographic units are more likely to support lynx longer than other units under projected climate change scenarios. Nonetheless, we are unaware of any management action that can abate the long-term retreat of boreal forests and changed snow conditions. Further, climate-induced frequency and intensity of wildfires and disease events ~~is~~are expected to increase, particularly in the western portion of the DPS, although we do not anticipate such events ~~in and of themselves~~ alone to cause the permanent loss of breeding lynx populations in the North~~west~~-central Washington Unit or any other unit.

With regard to the eastern geographic units (Minnesota and Maine), suitable boreal forest and snow conditions are projected to decline more severely than in the western units. Lynx habitat conditions in Maine are also likely to decline significantly by the end of the century as private forest management practices, particularly a decline in clearcutting, result in succession detrimental to snowshoe hare and lynx needs.

DPS viability

Although there is no evidence from the historical record that Canada lynx have declined within the DPS, a number of threats acting at the DPS and individual geographic unit scales indicate a moderate to high likelihood of declines (i.e., loss of two to four units) by the turn of the century. While it is more likely than not that any given individual unit—~~n~~Northern Maine, ~~n~~Northeastern Minnesota, ~~n~~Northwestern Montana, ~~w~~Western Colorado, and possibly ~~n~~North-central Washington—will persist to mid-century, t is unlikely all that five will persist to that point. By the end of the century, we expect populations to persist primarily in units having high-elevation refugia, e.g., northwestern Montana and possibly western Colorado, although Colorado would be an isolated unit. Lynx may also persist at the end of the century in Maine, depending on the severity of climate change effects and trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in concert with input from lynx experts indicates that all units will exhibit declines by 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the eventual loss of resiliency indicated by extirpation of geographic units will also reduce redundancy and, possibly, representation. These losses in resiliency, redundancy,

Comment [MJM25]: I can't tell what this is referring to. North-central Washington or Northwestern Montana.

Comment [MJM26]: This is good to know, but what I really want to know is the probability that all five will not persist to that point – i.e., the risk of ex inction.

Comment [MJM27]: But what is he risk that hey don't?

Comment [MJM28]: But what is he risk that hey will not?

and representation will put the Canada lynx U.S. DPS at increasing risk of extinction over the course of this century, and in all probability, the risk will continue to increase after that point.

Comment [MJM29]: This is a meaningless statement. All species are at increasing risk of extinction over time.

Chapter 1: Introduction

The U.S. Fish and Wildlife Service (Service) designated lynx in the contiguous U.S. as a distinct population segment (DPS) and listed it as threatened under the Endangered Species Act of 1973, as amended (ESA) in 2000 (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (U.S. District Court MT 2014b, p. 2). Thus, we conducted this SSA (version 1.0) to summarize the best available information on the current status and likely future viability of the DPS. This SSA will inform a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the ESA and (2) a recovery plan is needed to guide conservation and recovery of the lynx DPS.

1.1 Background

The Canada lynx is a North American wild cat that is most strongly associated with northern-latitude boreal forests (taiga) of Canada and Alaska (McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 373-374; Mowat *et al*. 2000, p. 272). It relies heavily on adequate populations of its primary prey, the snowshoe hare (*Lepus americanus*), to support survival, reproduction, recruitment, and, therefore, population persistence (Ruggiero *et al*. 2000a, p. 110; Mowat *et al*. 2000, p. 270; Steury and Murray 2004, pp. 128, 136-138; U.S. Fish and Wildlife Service 2005, p. 2; Interagency Lynx Biology Team [ILBT] 2013, pp. 30-34; 79 FR 54808-54809). Lynx survival and distribution is also influenced by snow conditions. It is generally restricted to areas that receive deep, powdery, and persistent snow that allows lynx, with their proportionately longer limbs and very large feet, to outcompete other terrestrial hare predators that are less efficient in such conditions (McCord and Cardoza 1982, pp. 748-749; Quinn and Parker 1987, p. 684; Buskirk *et al*. 2000a, pp. 89-94; Buskirk *et al*. 2000b, pp. 400-401; Ruggiero *et al*. 2000b, pp. 445–449; Hoving 2001, p. 75; Hoving *et al*. 2005, p. 744-749; Carroll 2007, entire; Gonzalez *et al*. 2007, entire; ILBT 2013, pp. 25-26; 79 FR 54809).

Lynx are generally considered secure, widespread, abundant, and distributed throughout most of their historic ranges in Canada and Alaska, which, combined, account for roughly 98 percent of the species' distribution. Lynx are distributed across approximately 5.5 million km^2 (2.1 million mi^2) in Canada (Environment Canada 2014, p. 2) and 534,454 km^2 (206,354 mi^2) in Alaska (University of Alaska Center for Science Conservation 2016, entire; Reimer 2016, pers. comm.). The southern peripheries of the boreal forest and the distributions of snowshoe hares and lynx extend into the northern contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 379-382; Hodges 2000, pp. 163-173; McKelvey *et al*. 2000a, pp. 242-253), where the six geographic units evaluated in this

SSA represent the remaining 2 percent of the species' breeding distribution (approximately 131,168 km^2 [50,644 mi^2]; see Figure 1 and Table 1, below). Lynx populations in the DPS seem to function as peripheral subpopulations (islands) of a larger (mainland) metapopulation centered in north-central Canada (McKelvey *et al*. 2000b, p. 25; 68 FR 40077; also see 2.2 below), and the demographic and genetic health and persistence of DPS populations are thought to be influenced by connectivity with, and immigration of lynx from, larger populations in Canada (McKelvey *et al.* 2000b, pp. 21, 33; Schwartz *et al.* 2002, entire; 78 FR 59434, 59447; 79 FR 54815).

Lynx were documented historically in 24 of the Lower 48 States (McKelvey *et al.* 2000a, pp. 207-232), but records in many places are associated with cyclic "irruptions" of large numbers of lynx dispersing from southern Canada when hare populations crashed; many of these occurrences were in anomalous habitats, and lynx were unable to persist and establish populations in most of these areas (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 242, 253; Aubry 2006, pp. 1-2; ILBT 2013, p. 23; see also section 2.3.2, below). Habitats capable of supporting persistent resident lynx populations in the contiguous U.S. occur over a much smaller geographic area that includes parts of the Northeast (primarily northern Maine), western Great Lakes (northeastern Minnesota), Rocky Mountains (northern Idaho, northwestern Montana; perhaps also parts of northeastern Washington, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming, and parts of western Colorado), and the eastern Cascade Mountains of northern Washington (68 FR 40077-40080; U.S. Fish and Wildlife Service 2005, p. 3; 79 FR 54806-54807; Lynx SSA Team 2016, pp. 6-7). Although uncertainty remains regarding the historic distribution of resident lynx in the contiguous U.S., and breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population decline in the contiguous U.S. has been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11; also see section 2.3.2, below).

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 14 states in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands (65 FR 16052). In 2003, in response to a court memorandum opinion on the 2000 listing rule, the Service reaffirmed its determination of the lynx DPS and its status as threatened under the ESA (68 FR 40076). The Service completed a recovery outline in 2005 (U.S. Fish and Wildlife Service 2005, entire), designated critical habitat for the DPS in 2006 (71 FR 66008) and, in 2007, again in response to a court order, clarified its determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS (72 FR 1186). Also in 2007, the Service initiated a 5-year status review of the DPS (72 FR 19549). The Service revised the critical habitat designation for the DPS in 2009 (74 FR 8616) and 2014 (79 FR 54782) and, concurrent with the latter, rescinded the state-based definition of the DPS boundary to formally extend ESA protection to lynx "where found" in the contiguous U.S., including New Mexico and other states that were not included in the original DPS range (79 FR 54804). The Service reinitiated the 5-year status review in 2015 (https://www.fws.gov/mountain-prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php), and that

review will be informed by this SSA report. On September 7, 2016, the U.S. District Court for the District of Montana remanded the 2014 critical habitat designation to the Service for further consideration.

The six geographic units evaluated in this SSA encompass all areas of the contiguous U.S. that currently support or are believed to have recently supported persistent resident lynx populations (Figure 1). Five of the six geographic units were designated as “Core Areas” in the Recovery Outline (USFWS 2005, pp. 4-6, 21, 23), and western Colorado was designated a “Provisional Core Area” (USFWS 2005, pp. 6, 21, 23). With the exception of western Colorado, these units also encompass and closely mirror the areas the Service designated as critical habitat in 2014 (79 FR 54782). Some areas adjacent to but outside these geographic units are known or suspected to intermittently support lynx home ranges and occasional reproduction. Uncertainty remains as to whether resident lynx populations occurred historically in other areas not encompassed by the geographic units evaluated here.

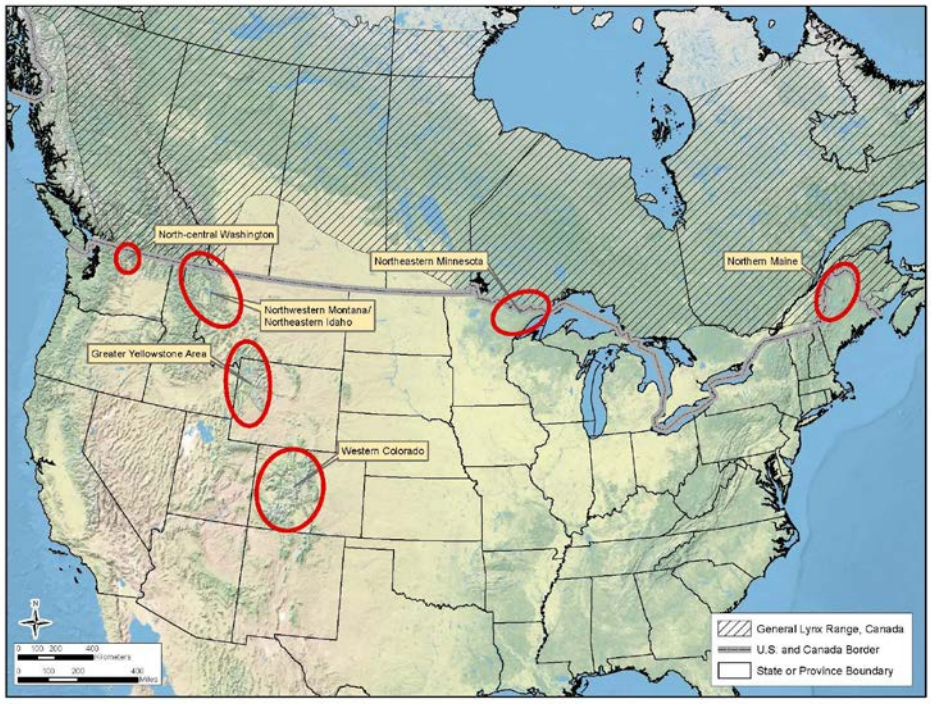


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*) that currently support or recently supported (GYA) resident lynx populations relative to the general range of lynx in Canada. Range in Canada based on Poole (2003), Koen *et al.* (2014), and Vashon (2015).

The six geographic units include federal, private, State, and Tribal lands. The amounts in each ownership vary among the units, with private lands predominating in Maine, a mix of ownerships in Minnesota, and federal lands predominating in the western units (Table 1).

Table 1. Lynx SSA Unit Sizes and Percent Ownership.

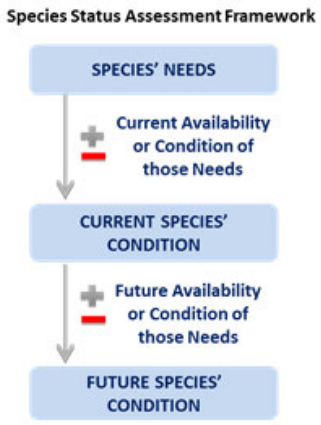
Unit[1]	Unit Size (km^2)	Percent of SSA Area	Land Ownership/Management (Percent)[2]						
			Federal				Private	State	Tribal
			All Federal	USFS	NPS	BLM			
1	28,909	22.0	0	0	0	0	91.6	7.3	0.9
2	21,101	16.1	47.4	44.9	2.5	0.01	15.5	36.2	1.0
3	26,997	20.6	84.3	69.3	13.6	1.5	8.0	4.1	3.5
4	5,176	3.9	91.5	84.6	6.7	0.1	0.3	8.2	0
5	23,687	18.1	97.6	79.7	16.7	1.1	2.2	0.3	0
6	25,294	19.3	90.1	85.2	1.8	3.1	9.3	0.6	0
All Units	131,164	100	63.6	55.6	6.8	1.1	26.5	8.8	1.1

[1] Unit 1 - Northern Maine; Unit 2 - Northeastern Minnesota, Unit 3 - Northwestern Montana/ Northeastern Idaho, Unit 4 - North-central Washington, Unit 5 - the Greater Yellowstone Area (southwestern Montana/Northwestern Wyoming), Unit 6 - Western Colorado.

[2] Unit sizes and ownership for units 1-5 are those calculated for the areas designated in 2014 as lynx critical habitat, including some Tribal, State and private lands that met the criteria for critical habitat but which were excluded from the designation in accordance with section 4(b)(2) of the Endangered Species Act. Unit 6 size and ownership were calculated by the Service's Western Colorado Field Office in coordination with Colorado Parks and Wildlife based on telemetry data from radio-marked lynx.

1.2 SSA Framework and Report

The Service is engaged in a number of efforts to improve the implementation of the ESA (see http://www.fws.gov/endangered/improving_ESA/). As part of this effort, our Endangered Species Program has developed the Species Status Assessment (SSA) Framework to guide how we assess the best scientific and commercial data available when evaluating the biological status of species. In conducting an SSA, we take into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time (captured under the broad heading of "species needs"); the current condition of the species at the individual, population, and range-wide levels in terms of meeting those needs; and the likely changes in the environment that may influence the species' future condition and, thus, the viability of the species.



The SSA Framework defines viability as a description of the ability of a species to sustain populations in the wild beyond a biologically meaningful time frame[1]. Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3 Rs") as a lens to evaluate the current and future condition of the species. Briefly, resiliency describes the ability of the species to withstand stochastic events; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. As a result, the SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings. Importantly, the SSA neither results in, nor predetermines, any decisions by the Service under the ESA.

The Species Status Assessment Report (SSA Report) is a summary of the information assembled, reviewed, and assessed by the Service and is based on the best scientific and commercial data available at the time of the assessment. Completed SSA Reports and supporting material can be found at the collaborative repository of the National Park Service and the USFWS called "ServCat" at the following IP address: *http://www.fws.gov/Refuges/NaturalResourcePC/landM/serviceCatalog.html*.

1.3 Analytical Approach/Methods

We used the SSA Framework (October 2015, version 3.3) described above to evaluate the current status of resident lynx in the contiguous U.S. as well as the likelihood that the geographic areas supporting resident lynx in the DPS would continue to do so in the near term and at mid- and end-of-century (years 2025, 2050, and 2100). We framed our evaluation in

[1] Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations in the wild over time. USFWS. 2015. Species Status Assessment Framework. Version 3.3. October 2015.

terms of the 3 Rs using conceptual modeling (Figure 2) based on available published literature, other information on the historic and current status of and threats to lynx in the DPS and, where empirical data are lacking, on formally-elicited expert opinion and best professional judgment (Lynx SSA Team 2016, entire).

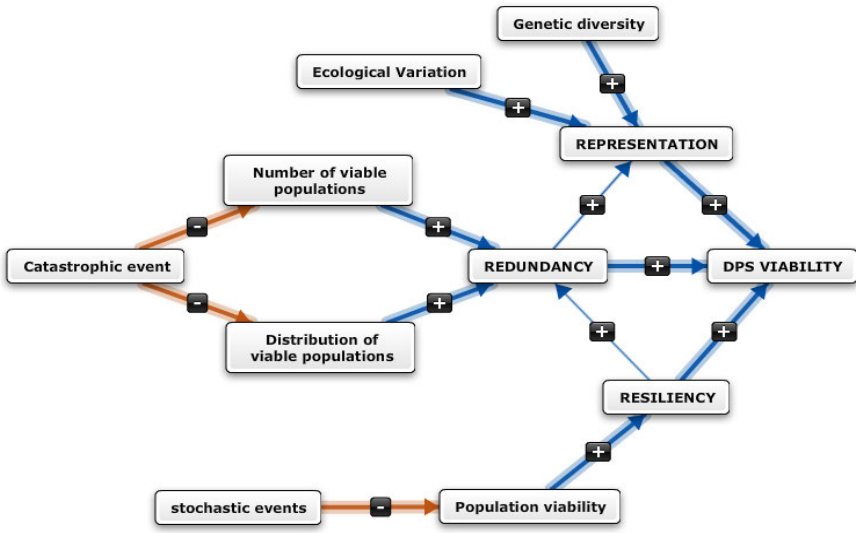


Figure 2. Conceptual model of the factors thought to influence the 3 Rs as they pertain to lynx viability.

We applied the definitions from the SSA Framework for the principles of redundancy, representation, and resiliency, provided in section 1.2, to Canada lynx as described below. We evaluated redundancy and representation at the scale of the DPS as a whole, and resiliency at the scale of lynx populations within each of the six geographic units.

To evaluate **redundancy** for the lynx DPS, we considered the current and likely future geographic distributions of resident breeding populations and whether the DPS is currently vulnerable to extirpation due to catastrophic event or would be in the future. Figure 3 shows examples of relationships among factors that may influence redundancy within the lynx DPS.

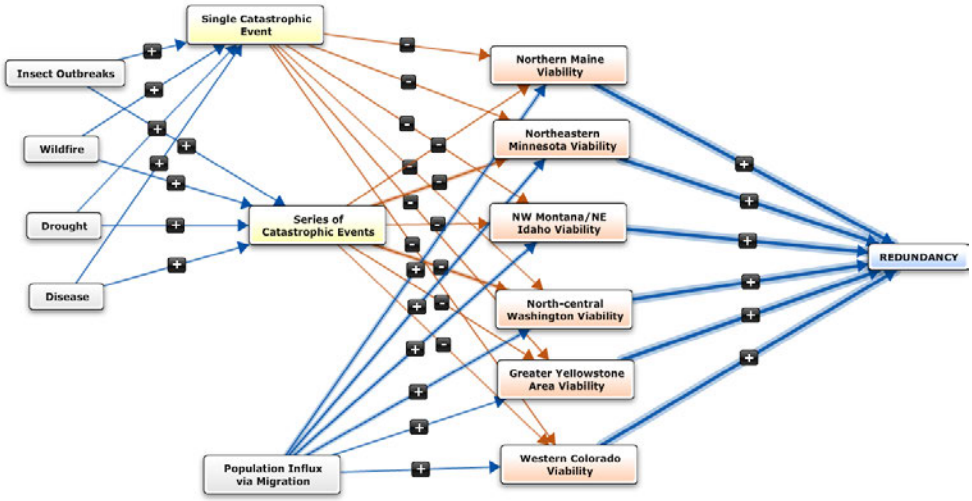


Figure 3. Conceptual model of factors thought to influence redundancy within the lynx DPS.

To evaluate **representation** for the lynx DPS, we considered measures of genetic diversity and heterozygosity, the current and likely future ecological diversity of geographic areas occupied by resident breeding populations, and the documented dispersal capabilities of the species, as shown in Figure 4 below.

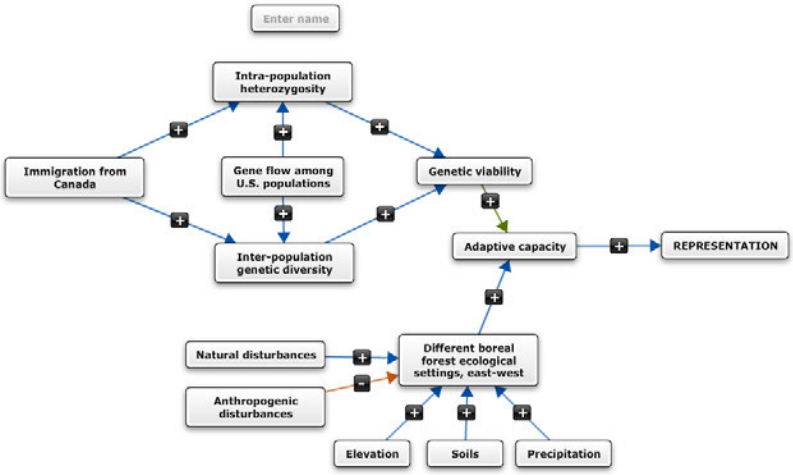


Figure 4. Conceptual model of factors thought to influence representation within the lynx DPS.

Because we lack reliable estimates of population sizes and trends, growth rates, and other long-term demographic data for most populations in the DPS, our evaluation of the **resiliency** of lynx

populations in the DPS was based largely on consideration of recent status updates and formally-elicited expert opinion regarding the likelihood that DPS populations will remain viable into the future. The relationships among factors that influence DPS resiliency are shown in Figure 5 below.

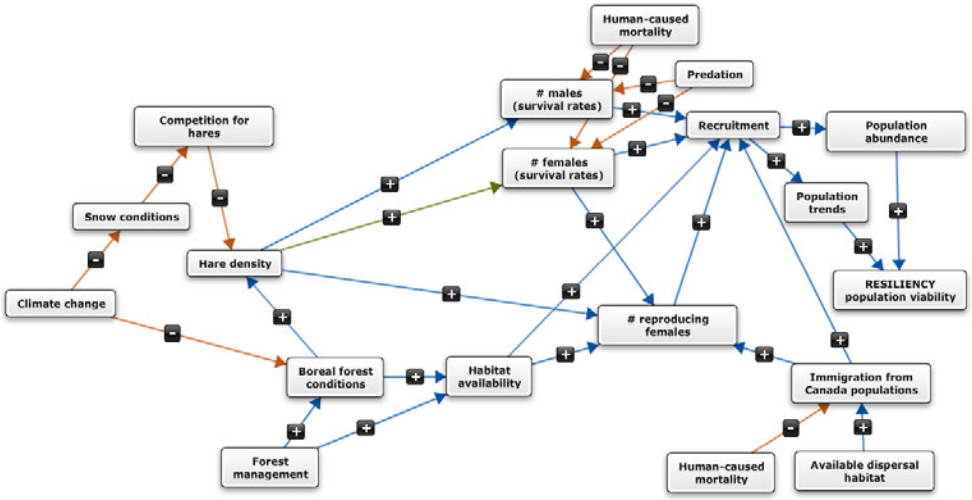


Figure 5. Conceptual model of factors thought to influence the resiliency of lynx populations within the DPS.

Chapter 2: Lynx Ecology

In this chapter, we describe the physical characteristics, taxonomy, and genetics of the Canada lynx, its life history and population dynamics, and its taxon-wide and DPS distributions. We rely heavily on recent summaries of this information provided in the revised *Canada Lynx Conservation Assessment and Strategy* (LCAS; ILBT 2013, entire), the Service's recent proposed (2013) and final (2014) rules to revise the designation of critical habitat for the DPS (78 FR 59430-59474; 79 FR 54782-54846), and the results of an October 2015 lynx expert elicitation workshop (Lynx SSA Team 2016, entire). We also provide a summary of the pertinent ecological requirements of lynx at the individual, population, and DPS levels. These ecological requirements form the basis of our analyses conducted in Chapters 3 through 5.

2.1 Species Taxonomy, Description, and Genetics

The Canada lynx (order Carnivora; family Felidae) is one of four species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). There are

three recognized subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. mollipilosus* ("Arctic lynx," Stone 1900), and *L. c. subsolanus* ("Newfoundland lynx," Bangs 1897) (Integrated Taxonomic Information System online database, http://www.itis.gov, retrieved April 14, 2016).

The Canada lynx is a medium-sized cat with long legs and large, well-furred paws. In winter, the lynx's fur is dense and has a grizzled appearance with a grayish-brown mix of buff or pale brown fur on the back, and a grayish-white or buff-white fur on the belly, legs, and feet. In summer, its fur is more reddish to gray-brown (McCord and Cardoza 1982, p. 730). It has long tufts of black hairs extending from the tips of its ears, a short, completely black-tipped tail, and often a distinct dish-like facial ruff of pale hairs tipped black. Lynx generally measure 75 to 90 cm (30 to 35 in) long and weigh 6 to 14 kg (14 to 31 lb) (Quinn and Parker 1987, Table 1; Moen *et al.* 2010a, Figure 2; Maine Department of Inland Fisheries and Wildlife 2012, unpublished data), and males are 13-25 percent larger than females (Mowat *et al.* 2000, p. 267). The lynx's large feet and long legs make it highly adapted for traversing and hunting in deep, powdery snow, where its low foot-loading (weight per surface area of foot) is thought to provide a competitive advantage (Buskirk *et al.* 2000a, p. 90; 2000b, p. 400; ILBT 2013, pp. 26, 36, 81) over other terrestrial predators of snowshoe hares, the lynx's primary prey. In southern Canada and the northern contiguous U.S, where the southern edge of the lynx range overlaps the northern edge of the bobcat range, the two species are easily confused because of their similar size and appearance. However, the lynx's longer ear-tufts, larger feet, and black-tipped tail distinguish it from the bobcat, which has shorter ear tufts, small feet, white on the underside of the tail, and is much more common and abundant than lynx in most of the contiguous U.S..

Overall, genetics research suggests high gene flow across most of the continental range of lynx, likely because of high dispersal rates, large dispersal distances, and the absence of significant barriers to genetic interchange throughout much of the lynx range, including the DPS (Schwartz *in* Lynx SSA Team 2016, pp. 11-12). Genetic evidence also indicates interactions between lynx populations even where physical barriers appear most likely to restrict gene flow. For example, although *L. c. subsolanus* on Newfoundland Island is genetically (Row *et al.* 2012, pp. 1262-1266; Koen *et al.* 2015, p. 528) and morphologically (Khidas *et al.* 2013, pp. 597-601) distinct from mainland lynx, there is evidence of genetic exchange between the two areas, indicating that some lynx are able to cross the 15-60 km-wide (9-37 mi) Strait of Belle Isle that separates them (Koen *et al.* 2015, p. 527). Similarly, despite some differences in functional genetic markers (unique alleles) in lynx south versus north of the St. Lawrence Seaway/River in eastern Canada, which suggest the potential for evolutionarily significant differences in those areas, recent analyses reveal genetic exchange among lynx on either side, indicating that some lynx successfully navigate this barrier (Koen *et al.* 2015, pp. 524-528; Bowman *in* Lynx SSA Team 2016, p. 12-13).

Schwartz *et al.* (2003, entire) documented reduced genetic variation (lower mean number of alleles per population and lower expected heterozygosity) among peripheral lynx populations compared to populations in the core of the lynx geographical range in Canada and Alaska. While recognizing that small changes in genetic variation can lead to large changes in

population fitness, the authors noted that the differences between core and peripheral populations in their study were small enough to suggest a lack of significant population subdivision (i.e., no indication of genetic isolation, substantial genetic drift, or potential genetic ‘‘bottlenecks’’ among DPS populations; Schwartz *et al.* 2003, p. 1814; 79 FR 54793). This finding is consistent with their earlier work, which documented high levels of gene flow (the highest yet documented for any carnivore) between core and peripheral lynx populations despite large separation distances (Schwartz *et al.* 2002, entire). Their results did not suggest that reduced genetic variation among peripheral populations was because of human disturbance (i.e., habitat loss/ fragmentation on the southern periphery of the geographic range; Schwartz *et al.* 2003, p. 1814), but they did imply that the persistence of lynx populations in the contiguous U.S. depends on dispersal from larger (core) populations (Schwartz *et al.* 2002, p. 522). Currently, there is no indication that the levels of connectivity and gene flow between lynx populations in the DPS and those in the core of the lynx’s range are inadequate to maintain the genetic health of DPS populations. Given the connectivity of most DPS units with lynx populations and habitats in Canada, the noted dispersal capabilities of lynx, evidence of dispersal in both directions across the Canada-U.S. border (Aubry *et al.* 2000, pp. 386-387; Squires *et al.* 2006a, p. 38; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and the small number of immigrants thought necessary to maintain genetic variability in peripheral populations (McKelvey *et al.* 2000b, pp. 23-24), genetic isolation, biologically meaningful genetic drift, or potential genetic ‘‘bottlenecks’’ appear unlikely among most DPS populations in the future (79 FR 54793).

Within the contiguous U.S., minor genetic sub-structuring has been documented among lynx subpopulations in western Montana (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5). Additionally, lynx-bobcat hybridization has been documented in Minnesota, Maine and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where male bobcats bred with female lynx to produce fertile offspring with lynx-like ear tufts, intermediate foot-size, and bobcat-like fur (ILBT 2013, p. 35). In Minnesota from 2000 to 2015, DNA analyses documented 13 distinct hybrid individuals (Moen and Catton *in* Lynx SSA Team 2016, pp. 13, 19); no hybrids have been documented in the western portion of the lynx’s range (Schwartz *in* Lynx SSA Team 2016, p. 12).

2.2 Life History and Population Dynamics

All aspects of lynx life history are inextricably tied to its primary prey, the snowshoe hare (Figure 6). Snowshoe hares comprise a majority of the lynx diet throughout its range (Nellis *et al.* 1972, pp. 323–325; Brand *et al.* 1976, pp. 422–425; Koehler 1990, p. 848; Apps 2000, pp. 358–359, 363; Aubry *et al.* 2000, pp. 375–378; Mowat *et al.* 2000, pp. 267–268; von Kienast 2003, pp. 37–38; Squires *et al.* 2004a, p. 15, Table 8, Olson 2015, pp. 60-69), and hare abundance is the major driver of lynx population dynamics. Lynx den site selection, litter sizes, pregnancy, as well as recruitment, survival (kitten, subadult and adult) and dispersal rates, and population age structure, home range sizes, density, and distribution are all strongly influenced by hare abundance (Koehler and Aubry 1994, pp. 75-76, 80-83; Apps 2000, entire; Aubry *et al.* 2000, pp. 375-390; Mowat *et al.* 2000, pp. 270-294; ILBT 2013, pp. 18, 22-24, 26-34).

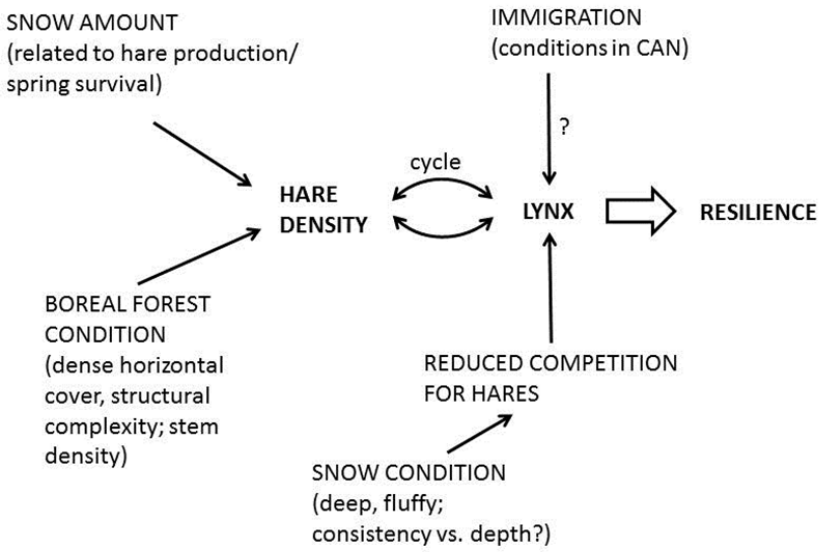


Figure 6. Generalized relationship between habitat conditions and hare and lynx population dynamics and their influence on lynx population resiliency.

Lynx are highly specialized predators of snowshoe hares and are dependent on landscapes with high-density snowshoe hare populations for survival and reproduction (McCord and Cardoza 1982, p. 744; Quinn and Parker 1987, pp. 684-685; Aubry *et al.* 2000, pp. 375-378). Lynx and snowshoe hares are strongly associated with what is broadly described as boreal forest (Bittner and Rongstad 1982, p. 154; McCord and Cardoza 1982, p. 743; Quinn and Parker 1987, p. 684; Agee 2000, p. 39; Aubry *et al.* 2000, pp. 378-382; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-191; McKelvey *et al.* 2000a, pp. 211-232). The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (*Picea* spp.) and fir (*Abies* spp.) (Elliot-Fisk 1988, pp. 34-35, 37-42). Snowshoe hares feed on conifers, deciduous trees, and shrubs (Hodges 2000b, pp. 181-183) and are most abundant in forests with dense understories that provide forage, cover to escape from predators, and protection during extreme weather (Wolfe *et al.* 1982, pp. 665-669; Litvaitis *et al.* 1985, pp. 869-872; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-195). Over much of the lynx's range, hare densities are higher in regenerating, earlier successional forest stages because they often have greater understory structure than mature forests (Buehler and Keith 1982, p. 24; Wolfe *et al.* 1982, pp. 665-669; Koehler 1990, pp. 847-848; Hodges 2000b, pp. 183-195; Homyack 2003, pp. 63, 141; Griffin

2004, pp. 84-88). However, snowshoe hares also can be abundant in mature forests with dense understories, particularly in the Northern Rocky Mountains (Griffin 2004, pp. 53-54; Griffin and Mills 2009, pp. 1492-1496; Hodges *et al.* 2009, p. 876; Squires *et al.* 2010, pp. 1653-1657; Berg *et al.* 2012, pp. 1483-1487). These mature forests may be a source of hares for other adjacent forest types (Griffin and Mills 2009, pp. 1492, 1495-1496), and they may provide especially important winter foraging habitats (Squires *et al.* 2010, pp. 1655-1657), which may be the most limiting habitat for lynx (Squires *et al.* 2010, pp. 1655-1657; ILBT 2013, pp. 17, 27). They also are more temporally-stable (i.e., they provide high-quality hare habitat for a longer period of time) than regenerating stands, which may foster high hare densities for a variable window of time between stand-initiation and stem-exclusion stages of succession, after which they may persist, in the absence of disturbance, for many years as lower-quality hare habitat (ILBT 2013, pp. 62, 71, 127).

Lynx habitat can generally be described as moist boreal forests that have cold, snowy winters and a snowshoe hare prey base (Quinn and Parker 1987, pp. 684-685; Agee 2000, pp. 39-47; Aubry *et al.* 2000, pp. 373-375; Buskirk *et al.* 2000b, pp. 397-405; Ruggiero *et al.* 2000b, pp. 445-447). Because lynx population dynamics, survival, and reproduction are closely tied to snowshoe hare availability, snowshoe hare habitat is the primary component of lynx habitat. However, lynx do not occur everywhere within the range of snowshoe hares in the contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729). This may be due to inadequate abundance, density, or spatial distribution of hares in some places, or the absence of snow conditions that would allow lynx to express a competitive advantage over other hare predators, or a combination of these factors (79 FR 54809).

The boreal forest landscape is naturally dynamic. Forest stands within the landscape change as they undergo succession after natural or human-caused disturbances such as fire, insect epidemics, wind, ice, disease, and forest management (Elliot-Fisk 1988, pp. 47-48; Agee 2000, pp. 47-69). As a result, lynx habitat within the boreal forest landscape is a shifting mosaic of habitat patches of variable and continually changing quality (68 FR 40077). These stands of differing ages and conditions provide lynx foraging or denning habitat (or may provide these in the future depending on patterns of disturbance and forest succession), and some serve as travel routes for lynx moving between foraging and denning habitats (McKelvey *et al.* 2000c, pp. 427-434; Hoving *et al.* 2004, pp. 290-292). Lynx generally concentrate hunting activities in areas where snowshoe hare densities are high (Koehler *et al.* 1979, p. 442; Ward and Krebs 1985, pp. 2821-2823; Murray *et al.* 1994, p. 1450; O'Donoghue *et al.* 1997, pp. 155, 159-160 and 1998, pp. 178-181; Fuller and Harrison 2010, entire; Simons-Legaard *et al.* 2013, pp. 573-575). Because understory density within a forest stand changes over time, hare habitat quality and corresponding hare densities also shift continually across boreal forest landscapes.

Hare populations in the core of the lynx range in Canada and Alaska undergo well-documented dramatic 8 to 11 year cycles during which hare numbers may fluctuate 10 to 25 fold or more, with peak densities as high as 23 hares/hectare (ha; 9.3 hares/acre [ac]) and lows of 0.1/ha (0.04/ac) (Hodges 2000a, pp. 117-121; Vashon 2015, p. 4). Hare densities are generally lower at the southern periphery of lynx distribution, and hare population cycles are generally much

less pronounced or absent entirely among some hare populations in southern Canada and in the contiguous U.S. (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17). In the contiguous U.S., stand-level hare densities may exceed 2 hares/ha (0.8 hares/ac) (Walker 2005, pp. 20, 85; McCann 2006, p. 15; Robinson 2006, pp. 26-36, 62-75; Homyack *et al.* 2007, pp. 10-11; Griffin and Mills 2009, p. 1492; Vashon *et al.* 2012, p. 14), but in many parts of the DPS, landscape-level densities are lower, ranging from just above to well below the 0.5 hares/ha (0.2/ac) density thought necessary to sustain lynx home ranges and populations (Hodges 2000b, pp. 168-169, 185; Ruggiero *et al.* 2000b, pp. 446–447; Squires and Ruggiero 2007, pp. 313-314; Maletzke *et al.* 2008, pp. 1476-1477; Zahratka and Shenk 2008, pp. 910-911; Hodges *et al.* 2009, pp. 873-877; Ivan 2011a, pp. 91-92, 95-102; Berg *et al.* 2012, p. 1483; ILBT 2013, pp. 24, 26, 90).

During lows in snowshoe hare populations, lynx prey opportunistically on other small mammals, especially red squirrels (*Tamiasciurus hudsonicus*), and birds, but alternate prey species do not sufficiently compensate for low availability of snowshoe hares, and lynx populations cannot persist over time in areas with consistently low hare densities (Brand *et al.* 1976, pp. 422–425; Brand and Keith 1979, pp. 833–834; Koehler 1990, pp. 848–849; Mowat *et al.* 2000, pp. 267–268). Nonetheless, even in areas with relatively low or marginal hare densities, hares constitute the majority of the biomass in lynx diets (Koehler and Aubry 1994, p. 85; Apps 2000, pp. 362-363; Aubry *et al.* 2000, pp. 375-378; Roth *et al.* 2007, pp. 2740-2741; Squires and Ruggiero 2007, pp. 310-313; Hanson and Moen 2008, p. 9; Maletzke *et al.* 2008, pp. 1475-1477; Shenk 2009, pp. 13, 16; Ivan *in* Lynx SSA Team 2016, Appendix 3, pp. 13-14).

Lynx typically mate in March and April, and kittens are born from late April to mid-June after a 60- to 70-day gestation period (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Female lynx typically reach reproductive maturity in their second year (at 22 months of age); however, when hares are abundant, females may breed at 10 months of age and produce kittens as 1-year-olds (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Males do not seem to breed as yearlings, and they do not contribute to rearing of young (ILBT 2013, p. 30). Lynx dens are typically located in areas of dense cover, where coarse woody debris, such as downed logs and windfalls, provides security and thermal cover for lynx kittens (McCord and Cardoza 1982, pp. 743-744; Koehler 1990, pp. 847-849; Slough 1999, p. 607; Squires and Laurion 2000, pp. 346-347; Organ *et al.* 2008, entire; Squires *et al.* 2008, pp. 1497, 1501-1505; Moen and Burdett 2009, entire). Dens have been documented in both mature and younger boreal forest stands (Mowat *et al.* 2000, pp. 274-275; Squires *et al.* 2008, p. 1497; ILBT 2013, pp. 29-30; 78 FR 59441-59442; 79 FR 54809-54810; Organ *et al.* 2008, entire), and the amount of structure (e.g., downed, large, woody debris, tip-up mounds) seems to be more important than the age of the forest stand for lynx denning habitat (Mowat *et al.* 2000, pp. 274-275, Organ *et al.* p. 1516). Denning habitat is not thought to be a limiting factor for lynx in the DPS (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517; Squires *et al.* 2008, p. 1505; ILBT 2013, p. 30; 79 FR 54790). Dens must be near foraging habitat to allow females to adequately provision dependent kittens, and females seem to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.*

2012, p. 16; ILBT 2013, p. 29). Females attend kittens at the natal den site and one or more alternate or maternal dens until kittens are about 6-10 weeks old (Squires *et al.* 2008, p. 1502; Vashon *et al.* 2012, p. 17; ILBT 2013, p. 29). Thereafter, kittens remain with their mothers through their first winter, apparently learning from her how to hunt and capture prey, initially on a small portion of her home range, but by fall on the larger area the female used before kittens were born (Mowat *et al.* 2000, pp. 269, 278). Juveniles remain closely associated with their mothers until February or March, when family groups begin to break up, with young typically dispersing in April and May (Mowat *et al.* 2000, pp. 278-279) to establish their own home ranges. Female offspring may establish home ranges overlapping or adjacent to their mother's home range and maintain mother-daughter bonds throughout their lives (Mowat *et al.* 2000, pp. 279-280). Male home ranges may slightly overlap adjacent male home ranges. While male home ranges typically overlap one to three female home ranges, and female home ranges are partially or completely encompassed by a male's home range, core areas within home ranges appear to be exclusive except during the breeding season (Koehler and Aubry 1994, pp. 90-91; Mowat *et al.* 2000, pp. 276-280; Vashon *et al.* 2012, pp. 17, 22-23). Fidelity to home ranges over several years has been documented for both sexes, but shifts and abandonment of home ranges have also been documented (Koehler and Aubry 1994, p. 91; Mowat *et al.* 2000, p. 277). Lynx have been documented to live up to 16 years in the wild (Kolbe and Squires 2006, entire).

Lynx populations in Canada fluctuate in response to the cycling of hare populations (Elton and Nicholson 1942, pp. 241–243; Hodges 2000a, pp. 118–123; Mowat *et al.* 2000, pp. 265–272), with synchronous fluctuations in lynx numbers emanating from the core of the Canadian population and spreading over vast areas, generally lagging hare numbers by one year (McKelvey *et al.* 2000a, pp. 232, 239; Mowat *et al.* 2000, pp. 266, 270). When hares are abundant, lynx have higher pregnancy rates and larger litter sizes, higher kitten survival, and lower adult mortality, resulting in rapid population growth during the increase phase of the hare cycle (Slough and Mowat 1996, pp. 955–956; Mowat *et al.* 2000, pp. 266, 270–272, 281–289). When hare populations are low, female lynx produce few or no kittens that survive to independence (Nellis *et al.* 1972, pp. 326–328; Brand *et al.* 1976, pp. 420, 427; Brand and Keith 1979, pp. 837–838, 847; Poole 1994, pp. 612–616; Slough and Mowat 1996, pp. 953–958; O'Donoghue *et al.* 1997, pp. 158–159; Aubry *et al.* 2000, pp. 388–389; Mowat *et al.* 2000, pp. 285–287). When hares decline, lynx mortality rates increase, largely because of starvation, and home range sizes and dispersal/ emigration rates also increase (Ward and Krebs 1985, pp. 2821–2823; O'Donoghue *et al.* 1997, pp. 156, 159; Poole 1997, pp. 499–503; Mowat *et al.* 2000, pp. 265–272, 278, 281–294). Lynx numbers decline dramatically during the ''crash'' phase of the hare cycle (Slough and Mowat 1996, p. 956; Mowat *et al.* 2000, pp. 283-285), when many lynx starve and many others abandon home ranges and disperse in search of food, with many of the latter also dying, often soon after initiating dispersal (Mowat *et al.* 2000, p. 293).

In Canada, lynx abundance may be 3 to 17 times higher at the peak versus the low of the hare cycle, with lynx densities reaching 30-45/100 km^2 (78-117/100 mi^2) in optimal dense regenerating forests 15-40 years post-fire, 8-20/100 km^2 (21-52/100 mi^2) in older forests or further south, and < 3/100 km^2 (< 8/100 mi^2) at the hare cycle low (Slough and Mowat 1996, pp.

952, 955; Mowat *et al.* 2000, p. 283; Hatler and Beal 2003, pp. 2, 5; Environment Canada 2014, p. 1). In southern Canada, where hares are less abundant and hare population cycles are muted or absent, lynx populations may be stable at 2-3/100 km^2 (5-8/100 mi^2) (Environment Canada 2014, p. 1). Lynx densities estimated in the contiguous U.S. have ranged from 9.2-13/100 km^2 (24-34/100 mi^2), including kittens, in Maine's highest-quality habitat when hares were abundant (Vashon *et al.* 2008, pp. 1483-1484; Vashon *et al.* 2012, pp. 14-15) to 2.3/100 km^2 (6/100 mi^2) in Washington when hare abundance was low (Koehler 1990, pp. 847-850). Correspondingly, hare abundance may also influence lynx home range size. Ward and Krebs (1985, pp. 2819-2820) documented a 3-fold increase in home range size in southwestern Yukon, from 13 km^2 (5 mi^2) on average when hares were abundant and increasing to 39 km^2 (15 mi2) when hare density was low. Poole (1994, pp. 613-614) documented a similar trend in the Northwest Territories, where lynx home range size increased from 17 km^2 (7 mi^2; males and females combined) when hares were abundant, to 44 km^2 (17 mi^2) and 62 km^2 (24 mi^2) for males and females, respectively, when hare numbers declined. In contrast, Breitenmoser *et al.* (1993, p. 552) reported no change in lynx home range size despite a 10-15 fold increase in lynx density as hare abundance increased in the southern Yukon. Similarly, in Maine, lynx home range size did not increase when hare densities declined from 2/ha (0.8/ac) to 1/ha (0.4/ac) (Mallett 2014, pp. 53-93). In general, hare and lynx densities are lower and lynx home ranges larger at the southern periphery of the lynx's range, including most of the contiguous U.S., and are similar to those of northern populations during the low phase of the hare population cycle (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367).

Lynx populations in the contiguous U.S. seem to function as subpopulations or southern extensions of larger populations in northern and eastern Canada (McKelvey *et al.* 2000b, pp. 21, 25, 33; 65 FR 16052–16082; 68 FR 40077–40099; 71 FR 66025–66035; 74 FR 8616–8641; Koen *et al.* 2015, pp. 527-528). Populations in the DPS are relatively isolated from one another, though most are directly connected via dispersal to lynx populations in Canada (McKelvey *et al.* 2000b, pp. 25-34; U.S Fish and Wildlife Service 2005, p. 2). Lynx disperse in both directions across the Canada–U.S. border (Aubry *et al.* 2000, pp. 386-387; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and this connectivity and interchange with lynx populations in Canada is thought to be important to the conservation of lynx populations in the DPS. (McKelvey *et al.* 2000b, p. 33; Schwartz *et al.* 2002, p. 522; U.S Fish and Wildlife Service 2005, p. 2; ILBT 2013, p. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187). However, whether and, if so, to what the extent the demographic and genetic health and persistence of populations in the DPS depend on regular or intermittent immigration of lynx from Canada remains uncertain (McKelvey *et al.* 2000a, pp. 241-242; 79 FR 54793).

2.2.1 Ecological Requirements of Individuals

At the most fundamental level, the needs of an individual lynx are met if:

1) it is born to a female that occupies a home range containing
    a) secure denning habitat,

b) adequate hare abundance to support lactation during the early kitten stage and later provisioning of the kitten with hare meat,
c) habitat (boreal forest and snow) conditions that reduce the likelihood and effect of competition from other hare predators, and
d) a low likelihood of encounters with lynx mortality agents (predators, trappers, vehicles, etc.);

2) the mother's home range occurs within a larger landscape that also contains adequate hare abundance and available habitat into which the yearling lynx may disperse and establish its own home range after the period of maternal dependence, with low likelihood of adverse competition and mortality; and

3) the larger landscape also supports other secure lynx home ranges and ensures the opportunity to encounter a lynx of the opposite sex, breed successfully, and contribute to the recruitment of at least one offspring into the breeding population during its lifetime.

In cyclic northern lynx populations, there is a strong element of timing that determines whether these individual needs will be met. During the decline and low phases of the hare population cycle, few kittens are born, very few survive until their first winter, and recruitment may collapse completely or nearly so for several successive years (Slough and Mowat 1996, entire; Mowat *et al.* 2000, pp. 266, 285-287). Therefore, even in the core of the species' range, a kitten born during a period of declining or low hare abundance is very unlikely to survive to independence, breed successfully, and replace itself within the breeding population in its lifetime. Conversely, a kitten born during the increase or high phase of the hare population cycle is much more likely to survive, establish a home range, breed successfully, and replace itself via recruitment of one or more of its offspring into the breeding population.

In southern lynx populations (southern Canada and the contiguous U.S.), hare population cycles are of lower amplitude or absent (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17), and hare and lynx abundances and lynx demographic rates are typically like those of northern populations during hare lows (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367). Therefore, the likelihood that an individual lynx will have its ecological requirements met sufficiently so that it may replace itself in the breeding population is probably consistently relatively low, perhaps similar to lynx born during hare declines/lows in the north. Also in the south, there are more diverse assemblages of potential competitors and predators, more natural patchiness and anthropogenic fragmentation of lynx habitat (fewer areas with adequate hare densities and favorable snow conditions distributed broadly across large landscapes), and higher road densities and, thus, greater potential for lynx-vehicle collisions (Wolff 1980, p. 128; Buskirk *et al.* 2000a, entire). These factors probably further reduce the likelihood that an individual lynx in the southern periphery of the range will survive, reproduce successfully, and have one or more offspring recruited into the resident breeding population.

Individual lynx require large areas of boreal forest landscapes to support their home ranges, provide hares in adequate abundance to meet their nutritional needs, provide breeding opportunities, and facilitate dispersal and exploratory travel. Female home ranges must also provide secure denning habitat in close proximity to foraging areas with high hare densities to allow females to adequately provision dependent kittens, and females appear to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). The size of lynx home ranges is strongly influenced by the quality of the habitat, particularly the abundance of snowshoe hares, in addition to other factors such as gender, age, season, and density of the lynx population (Aubry *et al.* 2000, pp. 382–385; Mowat *et al.* 2000, pp. 276–280). Generally, females with kittens have the smallest home ranges, likely related to their need to stay close to dens and dependent kittens, and males have the largest home ranges (Moen *et al.* 2005, p. 11; Burdett *et al.* 2007, p. 463; ILBT 2013, p. 24).

The increased natural patchiness and fragmentation of high-quality hare habitat where boreal forest conditions transition to temperate forest types require individual lynx in many parts of the DPS to maintain relatively large home ranges that include patches of higher hare densities within a matrix of lower-quality habitats with lower hare densities (ILBT 2013, p. 126; 78 FR 59434; also see 2.3.3, below). Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range (78 FR 59438). Annual home range sizes reported for lynx in the contiguous U.S. (Table 2, below) vary greatly across the DPS but are generally larger in the west than the east; however, differences should be interpreted with caution because different methods, sample sizes, and estimators were used to generate them (ILBT 2013, pp. 23-24).

Table 2. Reported annual home range sizes for Canada lynx in the contiguous United States.

Geographic Unit	Reported Lynx Home Range Size km^2 (mi^2)		References (pages)
	Female	Male	
N Maine	26 (10)	54 (21)	Vashon *et al.* 2012 (16-17)
NE Minnesota	17-21 (7-8)	160-267 (62-103)	Burdett *et al.* 2007 (460-463); Moen *et al.* 2008a (17)
NW Montana/ NE Idaho	43-115 (17-44)	122-238 (47-91)	Brainerd 1985 (20); Squires and Laurion 2000 (344); Squires *et al.* 2004a (13)
N-C Washington	37-91 (14-35)	49-69 (19-27)	Brittell *et al.* 1989 *in* Stinson 2001 (5); Koehler 1990 (847); Maletzke *in* Lynx SSA Team 2016 (21)
GYA	50 (19)	824 (318)	Squires *et al.* 2003 (12-13)

Comment [30]: Some of these home ranges seem to be presented as a range of values and others (e.g., ME, GYA) are a single value (a mean?). We should be consistent and present a mean and range, if these data are available.

W Colorado	75-704 (29-272)	103-387 (40-149)	Shenk 2008 (10)

Juvenile and adult lynx require about 400 and 600 grams (14 and 21 ounces) of food per day (for adults, 0.4-0.5 hares/day, 170-200 hares/year), respectively, to meet their basic nutritional requirements (Saunders 1963, p. 390; Nellis *et al.* 1972, pp. 324-325). Available research suggests that landscape-level hare densities >= 0.5 hares/ha (0.2/ac) are necessary to support lynx home ranges and resident breeding populations; lynx home range abandonment, dispersal, and mortality increase when hare densities are lower; and lynx may be unable to survive where landscape hare densities are below 0.3/ha (0.12/ac) (Ward and Krebs 1985, pp. 2819-2822; Slough and Mowat 1996, entire; Ruggiero *et al.* 2000b, pp. 446-447; ILBT 2013, pp. 26, 125). Recent research in the contiguous U.S. supports this - in northern Maine, areas with landscape hare densities of 0.74/ha (0.30/ac) supported resident breeding lynx, but areas with hare densities below 0.5/ha (0.2/ac) were not occupied by lynx (Simons-Legaard *et al.* 2013, pp. 567, 574-575). Likewise, in northeastern Minnesota, resident lynx maintained home ranges where landscape hare densities were 0.64/ha (0.26/ac). Voyageurs National Park, where hare density was estimated at 0.35/ha (0.14/ac), did not support resident breeding lynx (Moen *et al.* 2012, pp. 352–354).

In addition to adequate hare density, individual lynx require landscapes in which they are unlikely to encounter predators (mountain lion [*Puma concolor*], coyote [*Canis latrans*], wolverine [*Gulo gulo*], gray wolf [*Canis lupus*], fisher [*Pekania pennanti*], and other lynx) (ILBT 2013, pp. 33, 35). Although lynx have co-evolved with predators, the influence of predation on lynx populations is unknown (ILBT 2013, pp. 35-36), and mountain lions and coyotes are now more widespread and abundant in the southern periphery of the lynx distribution than they seem to have been historically (Buskirk *et al.* 2000a, p. 83; Gompper 2002, entire). Lynx also need landscapes where they are unlikely to suffer reduced fitness because of competition with other hare predators, or encounter traps or other anthropogenic causes of mortality. Except for fisher and marten (*Martes americana*), lynx predators and potential terrestrial competitors for hares (the species above plus bobcat; maybe red fox [*Vulpes vulpes*] in some situations) all have higher foot-loading (weight per surface area of the foot), making them less efficient at traveling and hunting in the deep powdery snow conditions favorable for lynx (Buskirk *et al.* 2000a, pp 86-95, Krohn *et al.* 2005, entire) and, therefore, likely limiting, at least seasonally, interactions between lynx and these species. Analysis of lynx occurrence data in the contiguous U.S. suggests that lynx require at least four months (December through March) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Where snow conditions do not consistently favor lynx, increased potential for predation and competition would be expected (Peers *et al.* 2013, p. 8). Finally, individual lynx are more likely to survive, breed, and replace themselves in the breeding population if they occupy home ranges where trapping is prohibited or trapping pressure is low (Slough and Mowat 1996, entire), high-speed/ high-volume roadways are absent (ILBT 2013, pp. 77-78), and other potential anthropogenic causes of lynx mortality are minimal.

In summary, individual lynx require large landscapes with hare densities that maximize their chances of (1) surviving to independence, (2) establishing and maintaining a home range, (3) breeding successfully, and (4) contributing genes to future generations (Breitenmoser *et al.*

1993, p. 552). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. The available science suggests that landscape-level hare densities consistently >= 0.5 hares/ha (0.2/ac) and favorable snow depth and conditions for about 4 months are needed to support lynx occupancy, reproduction, and recruitment. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or to do so inconsistently.

2.2.2 Ecological Requirements of Populations and the DPS

Lynx populations require essentially the same things that individual lynx do (see Figure 5 and section 2.2.1, above), but on a larger landscape with hare densities and habitat conditions capable of consistently supporting multiple home ranges, breeding and dispersal opportunities, and reproductive and survival rates such that recruitment and immigration will, on average over the long term, equal or exceed mortality and emigration (Pulliam 1988, pp. 652-654). To support persistent lynx populations, such landscapes must provide for the survival of at least some resident lynx even when hares are least abundant and/or other habitat features (e.g., snow conditions) are least favorable so that the population can recover, perhaps aided by immigration, when hare numbers and/or other habitat conditions recover or improve. As with individual lynx, populations are more likely to persist in landscapes where the effects of competition, predation, and human-caused mortality (e.g., trapping, vehicle collisions) are relatively lower.

In a mainland-island metapopulation structure like that thought to govern lynx population dynamics, the persistence of peripheral island populations is determined by colonization and extinction rates (McKelvey *et al.* 2000b, p. 25). Colonization is driven by the number of islands, the distances between them, and the species' dispersal capabilities and timing. Extinction rates are determined by population size and demographic and environmental stochasticity, with extinction more likely in smaller and more isolated populations (McKelvey *et al.* 2000b, pp. 25-31). Lynx populations in the DPS are at the periphery of the species' range and may behave as islands in a mainland-island metapopulation construct. In such a system, larger islands with higher habitat quality and in closer proximity to the mainland would be more likely to support persistent resident populations and to sometimes act as "sources" that produce surplus animals that may disperse to other islands. Smaller islands with lower habitat quality or at greater distance from the mainland may, in contrast, act as "sinks" that depend on immigration from source populations (McKelvey *et al.* 2000b, p. 30), and which may support resident lynx only occasionally, intermittently, or temporarily.

Formal population viability analyses (PVAs) have not been published for lynx populations in the DPS and may not be possible given limited data and natural temporal variation in demographic rates (McKelvey *et al.* 2000a, pp. 22, 30). Although some demographic data are available for most lynx populations in the DPS, most are limited to relatively few, small study areas or relatively short durations. There remains uncertainty about whether, and if so to what extent, the demographic health of DPS populations relies on immigration from northern (Canadian)

populations; and immigration rates are not known for DPS populations (McKelvey *et al.* 2000a, pp. 24-34). These factors likely preclude development of meaningful DPS-wide or unit-specific empirical population viability models (McKelvey *et al.* 2000b, p. 22).

Slough and Mowat (1996, p. 952, Table 4) calculated population growth rate (lambda, λ) = 2.03 (annual doubling) during the 4-year increase-to-peak phase for a lynx population in the core of the species' range in southern Yukon. This period of rapid growth was followed by a rate of λ = 1.01 (stable) during the first year of a hare decline, and λ = 0.10 and λ = 0.46 (rapid decline) during the first two years of the lynx population decline when hares were scarce. (Note – the value λ = 0.01 presented in Slough and Mowat (1996, p. 952, Table 4) appears to be an error; the correct value for λ in a population in which the estimated number of individuals declined from 135 in 1992 to 13 in 1993 should be 13/135 = 0.10 [as presented above]). However, the natural range in λ that would be expected among peripheral, isolated, or semi-isolated lynx populations where hares are non-cyclic or weakly-cyclic (i.e., in DPS populations), versus those that would signal long-term population decline or instability is unknown. Despite this, and the limitations noted above, Squires (*unpubl. data in* Lynx SSA Team 2016, p. 20) calculated population growth rates in northwestern Montana of λ = 0.92 for lynx in the Seeley Lake area (i.e., declining population trend, 1999-2007) and λ = 1.16 for lynx in the Purcell Mountains (increasing trend, 2003-2007). Likewise, McCollough (2016 *unpubl. data*; USFWS, Vortex10, deterministic population simulation) used demographic data from Vashon *et al.* 2012 (pp. 17-21) to calculate finite growth rates during a period of high hare density (λ = 1.16; increasing trend) and during a period of low hare density (λ = 0.88; decreasing trend) for the lynx population in northern Maine (see also section 4.1.1, below).

Although minimum viable population sizes have not been derived for lynx populations in the DPS, the Service's Recovery Outline (USFWS 2005, p. 5) suggested landscapes of at least 1,250 km^2 (483 mi^2) with sufficient boreal/subalpine habitat, hare densities (at least 0.5 hares/ha [0.2/ac]), and snow conditions favorable for lynx ("fluffy and/or deep...for sufficient periods to favor the competitive advantage of lynx"). These are the minimum landscape size and habitat conditions thought necessary to support a minimum lynx population of at least 25 adults based on a lynx density of one lynx per 50 square kilometers (USFWS 2005, p. 5). McKelvey *et al.* (2000b, p. 29) noted that extinction (extirpation) risk should decrease with increasing population size, and that extinction resulting from demographic stochasticity is very unlikely even for a population (generally; not specific to lynx) with as few as 20 reproducing females. Kramer-Schadt *et al.* (2005, entire) developed a spatially explicit population model for Eurasian lynx in Germany which they combined with demographic scenarios to evaluate the likely success of potential reintroduction efforts; they concluded that at least 10 females and 5 males would be required to establish a population with an extinction probability less than 5 percent over 50 years. Rodriguez and Delibes (2003, entire) evaluated extinction among populations of Iberian lynx; they found that extinction occurred only in small populations that occupied habitats of less than 500 km^2 and that extinction within 35 years was unlikely among populations occupying areas of at least 500 km^2 of adequate habitat quality.

In summary, lynx populations need large boreal forest landscapes with snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. These landscapes must have hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term. Immigration may be particularly important to the persistence and stability of lynx populations at the southern periphery of the range, including those within the DPS, where hare densities are generally low and hare populations are either non-cyclic or weakly-cyclic compared to northern populations. Low hare densities reduce the likelihood that lynx recruitment will consistently equal or exceed mortality, and non-cyclic or weakly-cyclic hare populations are unlikely to allow the rapid lynx population recovery observed in northern lynx populations when hare numbers increase dramatically after cyclic population crashes. Although immigration rates for DPS populations are unknown, as is the rate and periodicity of immigration needed to provide demographic stability among them, connectivity with and immigration from lynx populations in Canada is believed to be important to the persistence of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789).

2.3 Historic and Current Lynx Distribution

2.3.1 Lynx Distribution and Status in Canada and Alaska

The Canada lynx is broadly distributed across northern North America from eastern Canada to Alaska (McCord and Cardoza 1982, p. 729; Poole 2003, p. 361; Vashon 2015, p. 4; Alaska Center for Conservation Science 2016, p. 1). It is strongly associated with the expansive, continuous boreal forests of those areas, and its range largely overlaps that of its primary prey, the snowshoe hare, also a boreal forest specialist (Bittner and Rongstad 1982, p. 146; Mowat *et al.* 2000, pp. 268-269; Aubry *et al.* 2000, p. 375). In Canada, lynx are thought to occupy about 5.5 million km^2 (over 2.1 million mi^2), which represents 95 percent of their historic range in that country (Environment Canada 2014, p. 2), and over 89 percent of the species' entire distribution. Nationally in Canada, lynx are classified as secure, widespread, and abundant; they are managed for long-term population stability, with a conservative estimate of 110,000 individuals during cyclic lows; and no acute, widespread threats to lynx have been identified (Environment Canada 2014, entire; Vashon 2015, pp. 1-6). Provincially, lynx status is considered secure in British Columbia, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Northwest Territories, and the Yukon; sensitive in Alberta and Saskatchewan; at risk/endangered in New Brunswick and Nova Scotia; and undetermined in Nunavut (Environment Canada 2014, pp. 3-4; Vashon 2015, p. 1). Lynx were extirpated from Prince Edward Island (0.1 percent of lynx range in Canada) by the late 1800s, and on the mainland the southern margin of assumed lynx range has contracted northward in Quebec, southeastern

Ontario, Manitoba, Saskatchewan, and Alberta (Poole 2003, p. 361; Bayne *et al.* 2008, pp. 1192-1195; Koen *et al.* 2014, pp. 757-760).

In Alaska, lynx are distributed across roughly 534,454 km^2 (206,354 mi^2) of boreal forest habitats (University of Alaska Center for Science Conservation, http://akgap.uaa.alaska.edu/species-data/canadian-lynx-annual-distribution/#content, accessed 4/28/2016; Reimer 2016, pers. comm.), which represents about 8.7 percent of the species' distribution. Lynx in Alaska are apparently secure, with low to moderate threats, and populations appear stable statewide, although total abundance is unknown (Alaska Natural Heritage Program 2008, pp. 2-4). In both Alaska and Canada, lynx trapping is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Alaska Natural Heritage Program 2008, pp. 2-6; Vashon 2015, pp. 5-6). Along the Canada-U.S. border in provinces adjacent to DPS lynx populations, lynx trapping is prohibited in New Brunswick (adjacent to northeastern Maine) but regulated trapping is permitted in Quebec (adjacent to northwestern Maine, northern New Hampshire, and northern Vermont), Ontario (adjacent to northeastern Minnesota), Alberta (adjacent to northwestern Montana), and British Columbia (adjacent to northwestern Montana, northern Idaho, and northern Washington).

2.3.2 Lynx Distribution in the Contiguous United States

2.3.2.1 Defining Lynx Distribution at the Periphery of the Range

Several aspects of lynx population dynamics and dispersal patterns have resulted in inconsistent approaches and difficulty in defining the range and/or distribution of the species, especially at the margins (74 FR 66942). These, combined with uncertainty and ambiguity in the historical record of lynx occurrence, with early assessments based largely on trapping harvest records of questionable accuracy, particularly where lynx and bobcats overlap, and a reliance on anecdotal or unverified occurrence information (McKelvey *et al.* 2000a, pp. 208-210; 65 FR 16054), confound efforts to accurately portray the species' historical distribution in the contiguous U.S. and to assess the current distribution relative to historic conditions (79 FR 54814-54815; McKelvey *in* Lynx SSA Team 2016, p.11). They also have resulted in inaccurate portrayals of lynx distribution and misperceptions that the historic range of lynx in the contiguous U.S. was once much more extensive than is ecologically possible (68 FR 40080; 74 FR 66942).

The range of the lynx must be considered differently from those of other species that are less mobile and have more stable population dynamics. Because the lynx is highly mobile and has cyclic population dynamics that are tied to cyclic snowshoe hare populations, numbers of lynx naturally fluctuate and become extremely low at times during a cycle. Additionally, where snowshoe hare populations are not adequate, resident lynx populations cannot be sustained. Because of this, resident lynx populations never occurred everywhere boreal forest existed in the contiguous U.S. Where the boreal forest was naturally more patchy and marginal, the habitat was incapable of supporting an adequate snowshoe hare population that in turn was incapable of supporting a resident lynx population over time. As a result, only a few areas in the

contiguous U.S. historically supported an adequate quantity and quality of habitat to support resident lynx populations over time, and many historical lynx occurrences across a large area of the contiguous U.S. were likely dispersers. The occurrence of dispersing lynx is unpredictable, and dispersing lynx will likely continue to periodically move into areas that are not lynx habitat (68 FR 40077).

The dramatic, cyclic fluctuations in lynx populations across much of the range as they track cyclic hare populations and the mass synchronous dispersals (irruptions) of large numbers of lynx into the contiguous U.S. when northern hare populations crashed are well-documented (Elton and Nicholson 1942, entire; Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 219, 232-242; Mowat *et al.* 2000, pp. 281-294; ILBT 2013, p. 33). These events have resulted in records of lynx occurrence, in some cases very rarely, in others sometimes in large numbers and with intermittent (cyclic) regularity, in places that otherwise lack evidence of persistent lynx presence or the habitats and hare densities necessary to support a resident lynx population (U.S. Fish and Wildlife Service 2005, pp. 3-4; 79 FR 54787-54789, 54793-54795, 54812-54823). Many records of lynx in the contiguous U.S. appear to be related to such events, including the unprecedented ‘‘explosions’’ of lynx observed in the early 1960s and 1970s (Gunderson 1978, entire; McKelvey *et al.* 2000a, pp. 232-242). During these events, many lynx occurred in anomalous habitats, exhibited unusual behavior, suffered high mortality, and numbers declined dramatically within a few years of irruptive peaks (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, p. 242). Because dispersing lynx typically do not persist in these areas of temporary range expansion, disappearing fairly quickly after irruptions, van Zyll de Jong (1971, p. 16), suggested that only areas that support lynx populations throughout both the low and the high phases of the “10-year cycle” (i.e., across the natural range of hare densities) should be considered to constitute the species’ range. In its 2003 remanded determination, the Service determined that lynx in the contiguous U.S.exist either as resident populations or as dispersers, that dispersing lynx are often found repeatedly and for variable amounts of time in habitats that cannot sustain breeding populations over time (though some breeding may occur occasionally in some of these areas), and that such areas probably contribute little to the persistence of lynx in the DPS (68 FR 40077, 40079-80). This repeated dispersal into habitats that ultimately cannot support the species (‘‘sink’’ habitats) often leads to confusion among scientists and the public about where lynx populations may be viable (74 FR 66938).

In addition to distinguishing between historical occurrence records associated with irruptions/ dispersal and those suggesting resident lynx populations, the “mainland-island” metapopulation structure thought to govern lynx populations in the DPS (McKelvey *et al.* 2000b, pp. 25-31; see Section 2.2, above) and the transitional (and, therefore, increasingly fragmented and isolated) and spatially- and temporally-shifting nature of lynx habitat at the southern periphery of the range (Koehler and Aubry 1994, pp. 78-79; McKelvey *et al.* 2000b, pp. 29-30; 74 FR 66940; 79 FR 54814) also present challenges in defining the distribution of lynx. Both factors suggest that some areas of the contiguous U.S. may naturally support resident lynx only temporarily or occasionally when habitat conditions (both boreal forest vegetation supporting abundant hares and snow conditions favoring lynx) are adequate and/or when immigration is sufficient to offset

the lower productivity and recruitment rates expected among lynx populations in marginal or suboptimal habitats. McKelvey *et al.* (2000b, pp. 21, 29-31) described such habitats as "... source-sink mosaics that shift with disturbance and succession," and the contribution, if any, of these places (especially those that act more often as "sinks" than "sources") to the maintenance and persistence of lynx populations in the DPS remains questionable (74 FR 66938).

Finally, the southern periphery of the lynx's range, where lynx are rare in many places, overlaps with the northern distribution of the much more common bobcat; the two species are difficult to distinguish in the field, they often were not reliably differentiated in historical trapping records (McKelvey *et al.* 2000a, pp. 208-209), and errors in early accounts of lynx distribution based on anecdotal information seem likely (Halfpenny and Miller 1980, pp. 1, 3-8; Meaney 2002, pp. 3-5, Hoving *et al.* 2003, pp. 366-367; Krohn 2010, p. 33). Because of the large effect that relatively few errors in identification can have on assessments of the distribution of rare animals, especially those that are easily confused with a similar and more common species, McKelvey *et al.* (2000a, p. 209; 2008, pp. 553-554) suggest that anecdotal information should be interpreted with caution, and only verified occurrence data should be used to assess historical and current lynx distributions.

These complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with a naturally dynamic and transitional habitat, make it difficult, if not impossible, to precisely delineate the historic or current distribution of resident lynx populations in the contiguous U.S. (Koehler and Aubry 1994, p. 79; 68 FR 40084). While recognizing these limitations, we use our best professional judgment of the best scientific and commercial data available to make conclusions about the range of the lynx for the purposes of this SSA. In the following section, we describe the types and distributions of potential lynx habitats in the contiguous U.S., and our current understanding of the historical and current distributions of resident lynx populations in the DPS considering the factors discussed above.

2.3.2.2 Lynx Distribution within the DPS Range

The southern periphery of boreal forest vegetation extends into parts of the northern contiguous U.S., where it transitions to the Acadian forest in the Northeast (Seymour and Hunter 1992, pp. 1, 3), deciduous temperate forest in the Great Lakes regions, and subalpine forest in the Rocky Mountains and Cascade Mountains in the west (Agee 2000, pp. 40-41). In much of the DPS range, these boreal forest landscapes become naturally patchy and transitional because they are at the southern edge of the boreal forest range, and they are limited, particularly in the west, by elevation and/or aspect (Ruediger *et al.* 2000, p. 4-16; 68 FR 40090). There also is increased prevalence of non-forested land uses (e.g., agriculture, development) at the southern periphery of boreal forests. These factors generally limit snowshoe hare populations in the contiguous U.S. from achieving landscape densities similar to those of the expansive northern boreal forest in Alaska and Canada, where hares are generally more abundant and more evenly distributed across the landscape (Wolff 1980, pp. 123-128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373-375, 382, 394). Consequently, important foraging habitat for lynx is often more limited and fragmented in the

contiguous U.S. than in boreal forests of northern Canada and Alaska (Berg and Inman 2010, p. 6), and overall habitat quality is typically lower.

The habitats that lynx use in the contiguous U.S. are characterized by patchily-distributed moist forest types with relatively higher hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with lower landscape hare densities (ILBT 2013, p.126; 78 FR 59434). In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support higher hare densities where most lynx foraging occurs. In some areas, patches of habitat containing snowshoe hares become so small and fragmented that the landscape cannot support lynx home ranges (ILBT 2013, p. 77) or populations over time (68 FR 40077). Additionally, the presence of more snowshoe hare predators and competitors at southern latitudes may inhibit the potential for high-density hare populations (Wolff 1980, p. 128). As a result, lynx generally occur at relatively low densities in the contiguous U.S. compared to the high lynx densities that occur in the boreal forest of Canada when hares are abundant (Aubry *et al.* 2000, pp. 375, 393-394) or the densities of species such as the bobcat, which is a habitat and prey generalist.

Snow conditions also determine the distribution of lynx (Ruggiero *et al.* 2000b, pp. 445-449), which are morphologically and physiologically adapted for hunting snowshoe hares and surviving in areas that have cold winters with deep, fluffy snow for extended periods. These adaptations provide lynx a competitive advantage over potential competitors, such as bobcats or coyotes (McCord and Cardoza 1982, p. 748; Buskirk *et al.* 2000a, pp. 86-95; Ruediger *et al.* 2000, pp. 1-11; Ruggiero *et al.* 2000b, pp. 445, 450), which have a higher foot load (more weight per surface area of foot), causing them to sink into the snow more than lynx. Therefore, bobcats and coyotes cannot hunt efficiently in fluffy or deep snow and are at a competitive disadvantage to lynx. Long-term snow conditions presumably limit the winter distribution of potential lynx competitors such as bobcats (McCord and Cardoza 1982, p. 748) or coyotes. These adaptations may also help lynx avoid predators such as mountain lions (Squires and Laurion 2000, p. 346), which also have higher foot-loading (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, p. 123), making them less efficient in deep and fluffy snow conditions.

Based on verified historical data, lynx occurrence has been documented in 24 states in the contiguous U.S. (McKelvey *et al.* 2000a, 207-232) and, more recently, in a 25th after some of the lynx released into southwestern Colorado dispersed into northern New Mexico (Colorado Division of Wildlife 2000, p. 3; 74 FR 66938), which had previously lacked verified evidence of lynx occurrence (USFS 2009, entire; 74 FR 66940-66943). Of these, and based on our current understanding of lynx and hare habitat requirements, the Service concludes that records in at least 11 states (Connecticut, Illinois, Indiana, Iowa, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Pennsylvania, and South Dakota) most likely represent occasional dispersing lynx that arrived in places with no historic or recent evidence of the habitat quality or quantity necessary to support a persistent resident lynx population (68 FR 40099; 74 FR 66940-66942; 79 FR 54807, 54817). These states are not within the distribution of resident lynx in the DPS, and we conclude that they naturally lack the necessary habitat, hare densities, and snow

conditions and that they were not capable historically and are not capable now of supporting resident lynx populations.

The Service originally identified the DPS as occurring in forested portions of the remaining 14 states (Colorado, Idaho, Maine, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming; 65 FR 16052, 16085). Some of these states, and parts of others, are thought to have historically supported only dispersing lynx or to have only occasionally supported resident breeding lynx (68 FR 40099; 74 FR 66940). Such areas were included within the range of the DPS because of the possibility that lynx could establish small, local populations in them and perhaps contribute to the persistence of the DPS, though evidence of this was lacking (68 FR 40080; 74 FR 66938). In its 2003 remanded determination for the lynx DPS, the Service concluded that (1) potential lynx and hare habitats in Michigan, Oregon, Utah, Vermont, and Wisconsin were relatively small, isolated, and of marginal quality, and that available information suggested that these states did not historically or recently support resident lynx populations; (2) it was uncertain whether Colorado, New York, and Wyoming historically supported resident populations or only occasional dispersers; (3) New Hampshire probably supported a small resident populations that had been extirpated; and (4) the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) had the best historic and recent evidence of resident breeding populations (68 FR 40082, 40086-40095, 40097-40101). Below we provide our current understanding of these state groupings and the information available since the 2003 remand that informs this understanding.

Michigan, Oregon, Utah, Vermont, and Wisconsin - Additional information and analysis available since 2003 support the determination that Michigan (Linden 2006, pp. 83-90) and Oregon (Aubry 2006, pp. 1-2) did not historically or recently support resident lynx populations, and no evidence has emerged suggesting that resident populations occurred historically or recently in Utah or Wisconsin (ILBT 2013, pp. 45, 58). The best available information continues to suggest that resident lynx did not historically and do not currently occur in Michigan, Oregon, Utah, and Wisconsin; that habitats in these states are naturally incapable of supporting resident breeding populations; and that historic and potential future occurrences of lynx in these states most likely represent occasional dispersing lynx. We conclude, therefore, that these states did not historically, do not currently, and in the future are very unlikely to, contribute to the persistence and conservation of lynx in the contiguous U.S.

In contrast, nine lynx occurrences were confirmed in the 530-km^2 (205-mi^2) Nulhegan Basin of northeastern Vermont from 2003 to 2014, and breeding was confirmed in 2012; intensified surveys since then have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). This new information indicates that this small area of northernmost Vermont is at least occasionally capable of supporting a small number of resident breeding lynx, but that its ability to support a persistent resident population over time remains doubtful. Based on assessments of the amount and quality of potential lynx and hare habitat, snow conditions, and the presence and distribution of lynx competitors and predators (Hoving *et al.* 2005, pp. 746-749; Bernier 2015, entire), we conclude it is unlikely that northern Vermont can support a persistent resident lynx population (79 FR 54820-54821); that it only occasionally

supports lynx reproduction when hare abundance and snow conditions are temporarily adequate; that it most likely represents a “sink” rather than a “source” for the regional lynx population, and that this likely represents its natural historical condition.

Colorado, New York, and Wyoming - When the Service listed the DPS in 2000, it believed that a resident lynx population occurred historically in the Southern Rocky Mountains of western Colorado and southeastern Wyoming, that lynx were also historically resident in northwestern Wyoming (part of the Northern Rocky Mountains), and that the Adirondack Mountains of northern New York may historically have supported a resident population that was by then extirpated (65 FR 16055-16056; 16058-16059). In the 2003 remand, the Service noted inconsistencies and likely errors in historic lynx reports for the Southern Rockies, questioned its original conclusion that Colorado historically supported an isolated resident population, and concluded that it was uncertain whether a resident population occurred historically in Colorado or if historic records were of periodic dispersing lynx during “extremely high populations cycles” and that a resident population never existed in southeastern Wyoming (68 FR 40081, 40091). The Service also noted that in 1999 and 2000 the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) introduced 96 lynx from Canada and Alaska into southwestern Colorado (with plans to release an additional 186 lynx from 2003-2009) in an effort to reestablish a resident lynx population, that reproduction among some of the released lynx had been documented by 2003, but that it was too early to determine whether the program would be successful (68 FR 40091). In that rule, the Service also concluded that, despite evidence of reproduction in northwestern Wyoming (part of the GYA), potential habitat there is naturally marginal (patchier and composed of drier forest types), may be incapable of supporting a resident lynx population, and that lynx in northern Wyoming are most likely dispersers (68 FR 40090). Also in 2003, the Service concluded that it was possible resident lynx occurred in northern New York prior to 1900 but the potential habitat there is small, marginal, and likely has only supported dispersing lynx since then, and that an effort to reintroduce lynx there failed quickly, suggesting the habitat is incapable of supporting a resident population (68 FR 44486-44487).

In Colorado, after the initial release of 96 lynx in 1999 and 2000, none were released in 2001 or 2002 while protocols were evaluated and refined based on monitoring of the initially-released lynx (Shenk 2010, pp. 1, 4; Ivan *in* Lynx SSA Team 2016, p. 22). From 2003-2006, another 122 lynx were released, bringing the total to 218 (Devineau *et al.* 2010, p. 526). Reproduction was documented in 2003-2006 and 2009-2010, with 48 dens documented in that time, including a third generation of Colorado-born lynx (Shenk 2010, p. 5; Ivan *in* Lynx SSA Team 2016, p. 22). In 2010, CPW determined that all benchmarks for its lynx program had been met and had resulted in the establishment of a viable, self-sustaining lynx population (Ivan, 2011a, pp. 11, 12). Intensive monitoring of the population ceased in 2010 and was replaced by an effort to develop a minimally-invasive long-term monitoring program (Ivan 2011b, entire), which used snow-tracking surveys and camera traps to document continued lynx presence in the core release area of the San Juan Mountains in 2010-11 and again in 2014-15, with evidence of reproduction also documented during that time (CPW 2015, p.1; Ivan *in* Lynx SSA Team 2016, pp. 22-23). In its 2014 revised critical habitat designation for the DPS, the Service concluded

that the historic record of verified lynx occurrence in Colorado combined with naturally highly-fragmented and isolated potential habitat and generally low snowshoe hare densities suggest that Colorado and the Southern Rockies were unlikely to have historically supported a persistent resident lynx population and that the long-term persistence of the introduced population is uncertain (79 FR 54787-54789, 54793-54795, 54816-54817). The current size of the resident lynx population in Colorado is unknown but thought to number between 100 and 250 (Ivan *in* Lynx SSA Team 2016, p. 47). We continue to believe that available information suggests Colorado did not historically support a persistent resident lynx population and that the long-term persistence of the introduced population remains uncertain.

Information and analyses since the 2003 remand support the conclusion that New York has inadequate habitat quantity and quality (both vegetation and snow conditions) to support a resident lynx population (Hoving *et al.* 2005, pp. 746, 749). Based on Hoving *et al.* (2005) and our evaluation of the verified records of historic occurrence presented by McKelvey *et al.* (2000a, pp. 215-217), we conclude that the Adirondack Mountains of northern New York have not recently and likely did not historically support a persistent resident lynx population, are likely incapable of doing so, that verified historic records were most likely of dispersing lynx, and dispersing lynx may currently and in the future continue to occur rarely and temporarily in northern New York.

In northwestern Wyoming, additional information available since 2003 documented continued presence of a small number of lynx as recently as 2010, including some evidence of reproduction during that time, and documentation of Colorado-released lynx that dispersed into and through Wyoming (Squires *et al.* 2003, entire; Squires and Oakleaf 2005, entire; Murphy *et al.* 2006, entire; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Hanvey 2016, pers. comm.; Ivan 2016, pers. comm.; Murphy 2016, pers. comm.). However, more recent surveys and research-related trapping efforts have failed to detect lynx in this area or elsewhere in Wyoming since 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45). In the 2014 revised critical habitat designation, the Service noted:

> Although the GYA has a long history of lynx presence and recent evidence of reproduction (Squires and Laurion 2000, entire; Squires *et al.* 2001, entire; Murphy *et al.* 2006, entire), there are relatively few verified records of lynx from Yellowstone National Park and surrounding areas (65 FR 16058, 68 FR 40090). Additionally, lynx habitat in the GYA is naturally marginal (patchier and composed in many places of drier forest types), less capable of supporting snowshoe hares (Hodges *et al.* 2009, entire), and farther from source populations than most other parts of the DPS range (68 FR 40090). Given the naturally marginal habitat in this largely protected area, we believe it is unlikely that the GYA ever supported more than a handful of lynx home ranges in any given year. We find no evidence that the GYA once supported a larger or more robust lynx population than the small one suggested by verified historic and recent records and survey efforts (79 FR 54791).

We concluded that the historic record and recent evidence of lynx occupancy and reproduction suggested the presence of a small but persistent resident lynx population in the GYA of northwestern Wyoming and southwestern Montana (79 FR 54791, 54796-54797, 54825-54826); however, the consistency of occupancy over time remains uncertain (Lynx SSA Team 2016, pp. 11, 45, 57). Uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016, p. 57). If residency was intermittent historically, the current apparent absence of resident lynx might be a natural condition related to the area's largely marginal or suboptimal habitat conditions - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. In that case, future intermittent residency would be expected, but only if lynx dispersing from a source population immigrate to the GYA when habitat conditions and hare densities return to more favorable levels. Conversely, if the GYA always historically supported a small number of resident lynx but no longer does, it may suggest that some factor or factors have acted to tip the quality of the area's habitat from just barely capable of supporting a small resident population to no longer capable of doing so, resulting in extirpation. We conclude that this uncertainty cannot be resolved based on the available information but, given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its historic inability to support a robust, persistent resident population and its apparent recent inability to support any resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. We also note that extensive areas of the GYA were burned by the large, intense wildfires of 1988, and that these areas may soon (perhaps in the next 5-15 years) regenerate to a stage containing the dense horizontal conifer structure favorable for hares and, therefore, lynx foraging habitat, perhaps increasing the likelihood that the GYA may support resident lynx again in the near future (Lynx SSA Team 2016, p. 46).

In southern Wyoming, all recent occurrences of lynx appear to be of Colorado-released lynx that moved into or through the area (see Devineau *et al.* 2010, Fig. 1, p. 526), including one female who in 2004 established a den in the Snowy Mountains and produced kittens that did not survive (Bjornlie 2016, pers, comm.; Ivan 2016, pers. comm.). Based on the available information, we conclude that southern Wyoming did not historically or recently support a resident lynx population and is not now capable of doing so.

New Hampshire - There were 18 confirmed lynx records indicating 28 individual lynx in northern New Hampshire from 2006 to 2013, with evidence of reproduction in 2010 and 2011 (79 FR 54820). An additional 8 lynx detections were documented in 2014 (Siren 2014, p. 7), 24 lynx track intercepts were recorded during snow-tracking surveys during the winter of 2014-2015 (Siren 2016, p. 1), and surveys in 2016 also detected lynx (Siren 2016, pers. comm.). Most records since 2006 are in the vicinity of Pittsburg in the northernmost reaches of the state, though lynx detections in 2015 and 2016 suggest a southern expansion from the area of 2006-2014 detections (Siren 2016, p. 1; Siren 2016, pers. comm.). Despite recent evidence of lynx

residency and reproduction, the Service concluded in the 2014 revised critical habitat designation that, based on modeling of the amount of potentially suitable habitat and favorable snow conditions (Hoving *et al.* 2005, pp. 739, 749; Litvaitis and Tash 2005, p. A-298), it is unlikely that northern New Hampshire will support a resident breeding population over the long-term (79 FR 54820-54821). Siren (2014, p. 10) suspected that the relatively few lynx detections documented in 2012-2014 may be related to the presence and abundance of bobcat, coyote, and fisher populations in northern New Hampshire. We conclude that northern and central New Hampshire likely supported a small resident lynx population historically that was extirpated during the latter half of the 20th century. We are uncertain whether lynx detections in northernmost New Hampshire over the past decade may represent the natural reestablishment of a small resident breeding population in the state or if it is a temporary phenomenon related to an expanding source population in neighboring northern Maine (79 FR 54821). Although bobcat populations have increased and expanded their range in this region in recent decades (Lavoie *et al.* 2009, pp. 873-874), severe winters and deep snow can substantially limit their populations (Reed 2009, pp. 29-33; McCord, 1974, pp. 433-434). Maine's bobcat harvest declined substantially after two deep snow winters in 2008 and 2009 (Maine Department of Inland Fisheries and Wildlife 2015, p. 37). It is possible that these anomalous deep snow winters provided a temporary competitive advantage to lynx in northern New Hampshire.

Idaho, Maine, Minnesota, Montana, and Washington - These states (along with New Hampshire, above) have the strongest historical evidence of continuous lynx presence and recent evidence of resident lynx populations (McKelvey *et al.* 2000a, pp. 211-228; 68 FR 40086-40095, 40097-40101; McKelvey *in* Lynx SSA Team 2016, p. 11). Historic lynx records exist for much of Idaho, but many, especially in the central and southern part of the state, occurred in anomalous habitats or were associated with large irruptions of lynx from Canada to the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 225-227). The historic record and recent surveys (summarized at 79 FR 54818-54820; also see U.S. District Court ID 2016, pp. 18-24) suggest that only dispersing lynx occur throughout most of Idaho, habitats in many parts of the state are drier forest types that support lower densities of hares, and resident lynx seem to be confined to the Purcell, Selkirk, and possibly the Cabinet mountain ranges in the northern panhandle. The number of resident lynx in northern Idaho is unknown but certainly small based on the amount of potential habitat, and resident lynx here are part of a larger population that occurs primarily in northwestern Montana and southeastern British Columbia.

Maine has a long history of continual lynx presence, with evidence of a persistent resident population in much of the northern half of the state, which currently supports the largest lynx population in the DPS (Krohn 2010, entire; McKelvey *et al.* 2000a, pp. 211-212; Hoving *et al.* 2003, entire; Vashon *et al.* 2012, pp. 50-60; 79 FR 54784-54785, 54792, 54822-54824; Vashon *in* Lynx SSA Team 2016, p. 18). The lynx population in Maine is much larger than was suspected at the time of listing or the 2003 remand (potential habitat exists to support possibly 750-1,000+ individuals [Vashon *in* Lynx SSA Team 2016, p. 18], though a reliable population estimate is lacking). The current abundance of lynx is supported by the broad distribution of high-quality hare habitat that resulted from extensive, large-scale clearcutting in the 1970s and

1980s in response to a massive spruce budworm outbreak (68 FR 40087; 79 FR 54792; also see section 4.1.1, below). As these regenerating clearcuts, which currently provide the dense horizontal structure preferred by hares, mature beyond about 35 years post-harvest, hare densities decline as cover and forage are reduced due to forest succession (Simons 2009, p. 217). The current lynx population is probably larger than the likely historic condition, when relatively small amounts of the spruce-fir forests in the state are thought to have been composed of young stands (Lorimer 1977, entire; 68 FR 40094; Vashon *et al.* 2012, pp. 45, 56; 79 FR 54792). With the reduction in clearcutting following enactment of the Maine Forest Practices Act of 1989, it is projected that lynx densities in Maine will decline by 55 to 65 percent by 2032 (Simons 2009, p. 217). Lynx in Maine likely represent the southern periphery of a larger population that occurs in northern New Brunswick and southern Quebec south of the St. Lawrence Seaway/River, which appears to partially isolate lynx in this region, demographically and genetically, from populations in the core of the species' range (Koen *et al.* 2015, entire). The extent to which lynx persistence in Maine relies on immigration from Canada is unknown.

In Minnesota, research conducted since the 2003 remand has demonstrated the continuous presence of a resident lynx population in the northeastern part of the state that seems to be the southern periphery of a larger population in southwestern Ontario (Moen *in* Lynx SSA Team 2016, pp. 19, 39). The number of resident lynx in Minnesota is unknown but believed to be between 50 and 200 (Moen *in* Lynx SSA Team 2016, pp. 19, 39). Lynx are occasionally detected in other parts of the state, but hare densities and snow conditions consistently favorable for lynx appear to be restricted to the northeastern "Arrowhead" region of the state, and areas to the south and west are dominated by bobcats. Although there are currently more lynx in Minnesota than suspected at the time of listing, it is unclear whether current numbers and distribution are similar to the historical condition. The extent to which lynx persistence in Minnesota relies on immigration from Canada is also unknown.

In Montana, research conducted since the DPS was proposed for listing has documented the continued presence and broad distribution of resident lynx in much of the northwestern portion of the state (Squires *in* Lynx SSA Team 2016, p. 20). The number of resident lynx in northwest Montana is unknown but believed to be between 200 and 300 (Squires *in* Lynx SSA Team 2016, p. 41) in three subpopulations - the Purcell Mountains, Seeley Lake/Central, and Garnet Mountains subpopulations (Squires *in* Lynx SSA Team 2016, p. 20). Recent (2014-2015) surveys failed to detect lynx in the Garnet Mountains in the southern part of the area (Squires *in* Lynx SSA Team 2016, p. 20), which had residents as recently as 2010 and is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.). Lynx in northwestern Montana (and northern Idaho) likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia. The extent to which lynx persistence in this area relies on immigration from Canada is unknown, and there is no indication of substantial immigration from Canada after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). In southwest Montana, few lynx and no recent evidence of reproduction have been documented in the Montana portion of the GYA where, as with the northwestern Wyoming part of the GYA (discussed above), uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent

apparent absence from the area (Lynx SSA Team 2016, p. 57). As elsewhere in the West, recent research and habitat assessments suggest that habitats capable of supporting resident lynx in Montana are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12).

In Washington, research and monitoring conducted since the 2003 remand has continued to document a resident lynx population in the Okanogan region of the eastern Cascade Mountains in the north-central part of the state (von Kienast 2003, entire; Maletzke 2004, entire; Koehler *et al.* 2008, entire; Maletzke *et al.* 2008, entire; Maletzke *in* Lynx SSA 2016, pp. 21-22). Since at least 1985, this is the only area of the state with evidence of a resident breeding population (Koehler and Maletzke 2006, p. 4; Koehler *et al.* 2008, p. 1518; ILBT 2013, p. 58; Maletzke *in* Lynx SSA 2016, p. 21), although the Kettle Mountains in the northeastern part of the state are thought to have historically supported a small breeding population, and lynx are detected there occasionally (Stinson 2001, pp. 13–14; Koehler *et al.* 2008, p. 1523; USFWS 2008, p. 2). Multiple large fires in the Okanogan over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). Although these areas should regenerate into lynx and hare habitat, it may take 35-40 years (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and insect impacts could further diminish habitat availability and the lynx population's probability of persistence (Lynx SSA Team 2016, p. 44; see also sections 3.4, 4.1.4, and 5.1.4, below).

In summary, although uncertainty remains regarding the historic distribution of resident lynx in the DPS and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population declines in the contiguous U.S. from historical conditions until the DPS was listed have been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11). New information summarized above indicates that there are many more lynx in Maine and Minnesota than was suspected at the time of listing, and there are naturally fewer lynx and a more limited distribution of suitable habitats in the western U.S. than was previously thought (68 FR 40085, 40091-40092; ILBT 2013, p. 23). Lynx in Maine are at historically high numbers and may currently be facilitating the recolonization of formerly occupied habitat in northern New Hampshire, though lynx persistence in New Hampshire is uncertain and lynx numbers in Maine are projected to decline over the next several decades. In the West, small breeding populations in the GYA and the Garnet Mountains of Montana may recently have become extirpated (although both also may be only temporarily "winked off" in a metapopulation dynamics sense). In north-central Washington, lynx habitat and numbers have declined because of recent large fires and insect outbreaks, and the persistence of the breeding population there could be threatened if additional such impacts occur with similar magnitude and frequency over the next several decades. As a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, resident lynx currently occur in western Colorado. Although the number of lynx in this population and its future persistence are uncertain, Colorado currently

supports more lynx than it likely did, based on the historic record, for much of the previous century. The geographic units evaluated in this SSA include all areas in the contiguous U.S. with strong historical and recent evidence of persistent resident lynx populations. Detailed assessments of the current status and future viability of resident lynx populations and habitats in these areas are presented in chapters 4 and 5 below.

Chapter 3: Factors Influencing Viability of the DPS

In this chapter we discuss factors thought to influence the historic and current distribution and status of lynx populations in the contiguous U.S., their likely influence on the future viability of the DPS, and we describe the cause-and-effects pathways of impacts associated with particular factors. We focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in federal land management plans at the time of listing) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68-78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS.

3.1 Regulatory Mechanisms

A number of activities with the potential to affect lynx habitat suitability, productivity, mortality, and movements via habitat loss or fragmentation, creation of barriers, or that otherwise alter the vegetation mosaics and prey abundances maintained historically by natural disturbance processes may occur in lynx habitats regardless of land ownership and management. The extent to which regulations guide such activities to avoid, minimize, or mitigate impacts to lynx influences the current and future likelihoods that those habitats will provide the physical and biological features needed to support resident lynx populations. As described in more detail below, the lynx DPS was listed as threatened because of the lack of specific conservation direction and associated regulations on federal lands. At that time, the available information indicated that most lynx habitat in the DPS occurred on federal lands, predominantly in the western U.S. (65 FR 16061). Since then, research and monitoring have revealed that non-federal lands contribute more to the conservation of the DPS than was known at the time of listing, particularly in the Northern Maine and Northeastern Minnesota regions. Therefore, in the following sections we describe and compare the federal regulatory environment for lynx in the DPS at the time of listing and currently, and we describe other regulatory mechanisms as they pertain to lynx on private as well as State and Tribal lands.

Since it was listed in 2000, the DPS has been protected by the ESA's prohibition on take (under section 9), which applies to lynx wherever they occur in the DPS, regardless of land ownership. The DPS has also been protected since listing by section 7 of the ESA, which requires federal agencies to use their authorities to conserve listed species and to consult with the Service for any actions they implement, fund, or permit (i.e., for which a "federal nexus" exists) and which

may affect lynx or lynx habitats within the DPS, again regardless of land ownership. Additionally, section 4 of the ESA requires that critical habitat, defined as the specific geographic areas containing the physical and biological features essential for the conservation of a listed species and that may require special management and protection, be designated for listed species, and section 7 prohibits the destruction or adverse modification of such designated habitats. Critical habitat was designated for the lynx DPS in 2007 and was revised in 2009 and 2014. Section 4 also requires recovery planning for listed species; a recovery plan for the lynx DPS has not yet been completed, but part of the purpose of this SSA is to inform near-term recovery planning direction.

3.1.1 Federal Regulatory Mechanisms

Federal lands make up approximately 64 percent of the lands encompassed by the six geographic units evaluated in this SSA. Of those federal lands, roughly 87 percent is managed by the U.S. Forest Service (USFS), 11 percent by the National Park Service (NPS), and 2 percent by the Bureau of Land Management (BLM). The amount of federal land varies by unit, ranging from 0 percent in the Northern Maine Unit to over 97 percent in the GYA Unit (see Table 1, above, and Chapter 4, below, for ownership in each geographic unit). Federal lands management is guided by a number of statutes and associated regulations, policies, standards, guidelines, and best management practices applied by managing agencies to meet legislative mandates and achieve agency missions (for a summary of relevant Acts and associated regulations and guidance, see USFWS 2014, pp. 24-34). Many of these regulatory mechanisms provide some benefits to lynx and protect lynx habitats (USFWS 2014, pp. 24-34). For example, the conservation priority in the management of NPS lands in accordance with the National Park Service Organic Act (16 USC 1 et seq. as amended), the National Parks and Recreation Act (Public Law 95-625), and the Wilderness Act (16 USC 1131-1136, 78 Stat. 890) likely provides an adequate regulatory framework for the conservation of lynx populations and habitats in the NPS units in which they occur (USFWS 2014, pp. 28-29, 31-33). However, it was the absence of specific management direction and conservation measures for lynx and lynx habitats in USFS and BLM land management plans that led the Service to conclude that the regulatory mechanisms in those plans at the time of listing were inadequate to provide for the conservation of the DPS. Therefore, the evaluation below focuses on the efforts of USFS and BLM, in collaboration with the Service, to address the regulatory inadequacy for which the DPS was listed.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx populations and potential lynx habitats (broad forest vegetation classes defined as “lynx forest types” [65 FR 16071]) in the contiguous U.S. occurred on federal (USFS, NPS, and BLM) lands in the western states, and that the plans that guided management of those lands (particularly USFS and BLM lands) included “...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species” (65 FR 16052, 16082). At that

time, the Service found that USFS and BLM management plans did not adequately address risks to lynx and, as identified in the LCAS (Ruediger *et al.* 2000, pp. 2-1 through 6-3), those plans allowed actions that cumulatively could result in significant detrimental effects to lynx in the contiguous U.S. As a result, the Service concluded in the final rule that the lack of federal Land Management Plan guidance for the conservation of lynx and the potential for those plans to allow or direct actions that could adversely affect lynx constituted a significant threat to the DPS (68 FR 40096).

In 1998, in anticipation of the DPS's listing under the ESA, regional and state directors of the Service, USFS, BLM, and NPS approved preparation of the interagency LCAS to provide a consistent and effective approach to conserve lynx and to assist with Section 7 consultation on federal lands. An interagency Steering Committee selected a Science Team to assemble the best available scientific information on lynx and appointed the ILBT to prepare a lynx conservation strategy applicable to federal land management in the contiguous U.S. (USFWS 2014, p. 15). The first edition of the LCAS was completed in January, 2000 and revised in August, 2000 (Ruediger *et al.* 2000, entire). The Steering Committee subsequently issued several amendments and clarifications, and the most recent revision of the LCAS was completed in August, 2013 (ILBT 2013, entire). The LCAS initially identified and evaluated 17 risk factors (e.g., timber and fire management, recreation, roads, livestock grazing, trapping, etc.) thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements, and that may be addressed under programs, practices, and activities within the authority and jurisdiction of federal land management agencies. These risk factors included programs or practices with the potential to result in habitat conversion, habitat fragmentation, or obstruction to lynx movement; roads or winter recreation trails that may facilitate access to historical lynx habitat by competitors; and fire suppression, which changes the vegetation mosaic maintained by natural disturbance processes. The risks identified in the 2000 LCAS were based on potential effects to lynx habitats and to individual lynx, lynx populations, or both; therefore, not all of the risks initially identified in the LCAS were thought to threaten lynx populations in the DPS (68 FR 40096). In the 2013 revised LCAS, risk factors were redefined as "Anthropogenic Influences on Lynx and Lynx Habitat," and grouped into two tiers based on the potential magnitude of effects (ILBT 2013, pp. 1, 68). First tier influences (climate change, vegetation management, wildland fire management, and habitat fragmentation - discussed in the remainder of this chapter, below) are those with potential to negatively affect lynx populations and habitats, while second tier influences are those that may affect individual lynx but are not expected to substantially impact populations or habitats (ILBT 2013, pp. 68-85).

In addition to identifying risks, the LCAS also directed federal agencies to map potential lynx habitat and identify lynx analysis units (LAUs) to evaluate potential impacts of management actions on lynx and snowshoe hare habitats. Finally, the LCAS developed recommended conservation measures, standards, and guidelines to be applied to lynx habitats on federal lands that were designed to mimic historic conditions and landscape-scale disturbance patterns and to maintain or improve lynx and hare habitats at both local (project-level) and landscape scales (USFWS 2014, p. 16). After its initial completion in 2000, USFS and BLM managers within the range of the DPS agreed to implement the standards and guidelines identified in the

LCAS until management plans could be formally amended to specifically address lynx conservation. In 2000, the Service, USFS, and BLM developed and adopted Canada Lynx Conservation Agreements (CAs; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire) in which the BLM and USFS agreed to coordinate assessment and planning efforts with the Service to assure a comprehensive approach to lynx conservation and to use the LCAS, supporting science, and locally specific information as the basis for the approach and to streamline consultation under section 7 of the ESA. The USFS further committed to deferring any actions not involving third parties that would adversely affect lynx until such time as the Forest Plans were amended or revised to adequately conserve lynx (USFS and USFWS 2000, p. 8; 68 FR 40083).

Concurrent with development of the LCAS and interagency CAs, the USFS and BLM in 1999 completed the *Biological Assessment* (BA) *of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx* (USFS and BLM 1999, entire). The BA identified and evaluated the potential effects to lynx of implementation of 57 USFS Land and Resource Management Plans and 56 BLM Land Use Plans throughout the 14 states in which the lynx DPS was proposed for listing. The BA concluded that the potential for adverse effects to lynx existed on each administrative unit in each geographic area and that, cumulatively, implementation of the existing plans was likely to adversely affect the DPS. It recommended that all of the plans be amended or revised to incorporate conservation measures to reduce or eliminate adverse effects to lynx (USFS and BLM 1999, p. 14). In its 2000 biological opinion on the BA, the Service evaluated the USFS and BLM plans in conjunction with the CAs described above (USFWS 2000, p. 15). The Service concluded that implementation of the existing plans in accordance with the CAs until plans could be formally amended or revised was not likely to jeopardize the DPS, but that amendments or revisions to those plans were needed to further reduce or avoid the potential for adverse effects to lynx (USFWS 2000, pp. 48-50).

In the 2003 remanded rule, the Service similarly determined that adherence to the CAs, the biological opinion, and the LCAS in assessing the impacts of federal actions on lynx alleviated the effects of federal land management activities on lynx, but that amendment of USFS and BLM land management plans to conserve lynx would be the strongest mechanism to ensure long-term conservation of lynx and lynx habitat on federal lands (68 FR 40096-97). It concluded that although federal, State, and Tribal regulations and plans had reduced threats to the DPS, the inadequacy of existing regulatory mechanisms still posed a moderate, albeit lower-level threat, and would continue to do so until federal land management plans were specifically amended to address lynx conservation (68 FR 40097).

Since the 2003 remand, most Forest Service units with lynx forest types have formally amended or revised their land management plans to incorporate the conservation measures, standards, and guidelines identified in the LCAS. From 2004-2006, forest plans for seven national forests with potential lynx habitat in Maine, New Hampshire, Vermont, Michigan, Minnesota, and Wisconsin were revised to include recommendations from the LCAS and the CAs (Jackson 2015, pers. comm.; USFWS 2104, p. 33). In 2007, the USFS completed the Northern Rockies

Lynx Management Direction (NRLMD), which formally amended management plans to include lynx conservation measures, standards, and guidelines for 18 national forests covering over 150,000 km^2 (57,915 mi^2) in Idaho, Montana, Wyoming and Utah, including over 72,000 km^2 (27,800 mi^2) of potential lynx habitat (USFS 2007, entire; USFWS 2014, pp. 16-19; 79 FR 54813; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). In 2008, USFS similarly completed the Southern Rockies Lynx Amendment (SRLA), which formally amended forest plans covering about 59,000 km^2 (22,780 mi^2), including over 30,000 km^2 (11,583 mi^2) of mapped (potential) lynx habitat on 7 national forests or national forest complexes in western Colorado and southern Wyoming (USFS 2008, entire; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). The management direction adopted in the Northern and Southern Rockies amendments was developed in accordance with the National Forest Management Act of 1976 and the regulations that implement the statute (36 CFR 219.22), which requires public review and comment as part of the decision making process. Among national forests within the geographic units evaluated in this SSA, only those in Washington (the Okanogan-Wenatchee and Colville national forests) have not formally amended or revised their land and resource management plans. However, the plan revision process has been initiated for both forests, and both continue to manage for lynx habitats in accordance with the LCAS and the CA.

BLM lands account for just over 1 percent of the total area within the SSA geographic units, and most occur in Colorado, Montana, and Wyoming (Table 1, above). In the Western Colorado SSA unit, BLM Field Offices that contain potential lynx habitat include the Colorado River Valley, Grand Junction, Gunnison, Kremmling, Little Snake, Royal Gorge, San Luis Valley, Tres Rios, Uncompahgre, and White River Field Offices. These BLM areas were subject to the 2000 interagency CA; however, that CA expired in 2004 (BLM and USFWS 2000, p. 8) and was not renewed. Since then, BLM Resource Management Plans (RMPs) have been revised on the Colorado River Valley, Grand Junction, Kremmling, Little Snake, and Tres Rios Field Offices. RMPs for the Gunnison, Royal Gorge, San Luis Valley, Uncompahgre, and White River Field Offices have not been revised and do not contain specific measures for the conservation of lynx. BLM lands in the Garnet Resource Area in Montana and parts of the Kemmerer and Pinedale districts in Wyoming occur within the Northwestern Montana/Northeastern Idaho and GYA SSA geographic areas, respectively. These areas were also designated as lynx critical habitat. The RMP for the Garnet area was amended in 2004 to formally adopt the conservation measures of the LCAS (BLM 2004a, 2004b, entire), and the RMPs for the Pinedale and Kemmerer districts were revised in 2008 and 2010, respectively, to adopt conservation measures and best management practices for lynx (BLM 2008b, pp. A18-10 - A18-16; BLM 2010b, pp. A-9 - A-12).

The completion and implementation of the LCAS, the interagency CAs, and the subsequent formal management plan revisions and amendments all were undertaken to address the inadequacy of regulatory mechanisms on USFS and BLM lands for which the DPS was listed. Each incorporated the best available scientific information to develop goals, objectives, conservation measures, standards, and best management practices (BMPs) to guide USFS and BLM management activities at both project- and landscape-level scales to reduce or eliminate the potential for adverse effects to lynx or its habitats and thus promote the conservation of the DPS (Ruediger *et al.* 2000, pp. 7-1 - 7-18; BLM and USFWS 2000, entire; USFS and USFWS

2000, entire; USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). Standards and guidelines developed and implemented in accordance with the NRLMD and the SRLA were designed to limit potentially adverse effects and promote beneficial effects of management activities (vegetation management [e.g., timber harvest, precommercial thinning], wildland fire and fuels management, grazing, recreation, road/access management, energy development, etc.) on important lynx habitats including winter snowshoe hare habitat (high-quality lynx foraging habitat), denning habitat, and linkage/connectivity corridors (USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). The USFS concluded that the vegetation standards adopted in the NRLMD that limit the total amount and the rate at which lynx habitat can be converted to temporarily unsuitable habitat (stand initiation seral stage following timber harvest) ensure that the agency's timber management program is beneficial to lynx and will provide sufficient lynx habitat through time at both LAU and landscape-level scales (USFS 2007, p. 35). In its biological opinion on the NRLMD, the Service concluded that its application "...would substantially reduce or eliminate adverse effects to lynx from Forest Service land management activities on at least 94 percent of this area, and more likely nearer to 98 percent" (USFWS 2000, p. 76). Similarly, in its 2008 biological opinion on the SRLA, the Service concluded that vegetation management standards in the SRLA would prohibit treatments that could adversely affect essential components of lynx habitat on 95.5 percent of the mapped (potential) lynx habitat in the SRLA area (USFWS 2008, p. 52).

In summary, all USFS and some BLM lands with known or potential lynx habitat within the range of the DPS, including all SSA geographic units, are currently managed in accordance with the specific conservation measures and considerations identified in the LCAS and implemented via the CAs or formally revised and amended management plans described above. These agreements and revised/amended plans constitute the regulatory framework and specific regulatory mechanisms adopted to conserve lynx habitats and populations on USFS and BLM lands that support or are capable of supporting them. They represent the agencies' efforts, in collaboration with the Service, to address and ameliorate the singular threat for which the lynx DPS was listed under the ESA. Although formal effectiveness monitoring has not been completed, it's clear that implementation of the CAs and revised/amended plans, and the associated programmatic and project-specific consultations between BLM/USFS and the Service in accordance with section 7 of the ESA, have resulted in avoidance/minimization of impacts to important lynx and hare habitats on federal lands and have reduced the likelihood that management activities on these lands may adversely affect lynx in the contiguous U.S.

3.1.2 State Regulations and Tribal Management

Private, State, and Tribal lands make up the remaining 36 percent of the lands encompassed by the six geographic units evaluated in this SSA, accounting for almost 27 percent, almost 9 percent, and 1 percent of the total, respectively (Table 1). The amount of private land varies by unit, ranging from 0.3 percent in the North-central Washington Unit to almost 92 percent in the Northern Maine Unit. Likewise, State ownership varies from less than 1 percent in the GYA and Western Colorado units to 36 percent in the Northeastern Minnesota Unit. Tribal lands account for about 4 percent of the Northwestern Montana/Northeastern Idaho Unit and roughly 1 percent

of the Northern Maine and Northeastern Minnesota units; there are no Tribal lands in the North-central Washington, GYA, or Western Colorado units. Private, State, and Tribal lands, combined, constitute all of the lands in the Northern Maine Geographic Unit and over half of those in the Northeastern Minnesota Unit. Because both of these units support larger resident lynx populations than was known when the DPS was listed and, therefore, may contribute more substantially to the conservation of the DPS than was understood at the time of listing, we must evaluate the regulatory mechanisms that pertain to lynx on these lands (Lynx SSA Team 2016, p. 54). Although private, State, and Tribal lands constitute much smaller proportions of the other four (western) geographic units (from about 3 percent to 16 percent, combined), important lynx habitats occur on some of those lands, and regulatory mechanisms may influence their contributions to the conservation and persistence of DPS populations or parts of them. Therefore, in this section, we summarize the relevant regulatory frameworks and mechanisms that may affect lynx on private, State, and Tribal lands within the six geographic units of the DPS, but with a focus on those units with the greatest proportions of these lands and on activities on these lands with the greatest potential to impact lynx.

State Wildlife Management Regulations - The following information is derived from the Service's 2014 Incremental Effects Memorandum prepared in support of the revised designation of critical habitat for the lynx DPS (USFWS 2014, pp. 35-38) and updated as warranted by new information. State furbearer and other wildlife management regulations benefit lynx populations in the states where they occur. In addition to State and private lands, State wildlife regulations govern hunting and trapping activities on many federal lands where those activities are permitted. Most states within the range of the lynx prohibited trapping and hunting of lynx prior to the 2000 listing of the DPS under the ESA, and those activities were prohibited in all states once the DPS was listed. All states within the lynx DPS range that allow legal bobcat harvest (1) manage in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Export Program for Appendix II Furbearer Species (USFWS 2014, pp. 25-26), (2) have distributed information to bobcat trappers and hunters on how to avoid incidental take of lynx, and (3) report all known incidences of incidental take of lynx to the Service's Division of Management Authority to assure that take does not exceed the amount permitted under the intra-agency section 7 consultation for the CITES Export Program (USFWS 2001, entire). Most states have also adopted special regulations in areas where lynx occur to minimize the potential for incidental take of lynx during legal trapping of other furbearers. These efforts benefit lynx and are expected to do so in the future with continued implementation and enforcement.

Unit 1: Northern Maine - In 1967, a bounty on lynx in Maine was repealed, and lynx were given complete protection from trapping and hunting. The Maine Department of Inland Fisheries and Wildlife (MDIFW) has adopted special trapping regulations where lynx may occur that address specifics about traps types and sets that may be used to legally harvest other furbearers and that are intended to minimize the likelihood of incidentally trapping lynx (http://www.eregulations.com/maine/hunting/lynx-protection-zone-trap-restrictions/). MDIFW also adopted and made available for download on its web page the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*, and

modified it to be more specific to Maine. MDIFW also set-up an incidental lynx capture hotline and requires that all incidentally trapped lynx be reported (http://www.maine.gov/ifw/hunting_trapping/trapping/avoid_lynx.htm, last accessed 8.08.2016), and has staff on stand-by to help immobilize, evaluate, collect tissue and/or hair samples, and release, if appropriate, any lynx reported to the hotline. This program has resulted in the release of 98 lynx from 2000 - 2015 (10 died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine (MDIFW 2014, p. 75). In 2014, the MDIFW obtained an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping in Maine. After two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx (see Other Factors in section 4.1.1 below). The regulations now require exclusion devices on killer-type traps, prohibit the use of drag sets on foothold traps, address specific trap types and sets, prohibit visual use of bait and visual attractants, swivels on chains, and require reporting of incidental captures. The trapping permit is currently being litigated in federal court. The MDIFW also is responsible for implementing the Maine Endangered Species Act (http://www.mainelegislature.org/legis/statutes/12/title12sec12803.html; MDIFW 2009, p. 9). Although the lynx is not State-listed as threatened or endangered because its population is estimated to exceed the State's listing threshold, it is considered a species of special concern (MDIFW 2011, p 2). The MDIFW works collaboratively with the Service to conduct research and monitor lynx populations and habitats, and it recommends voluntary forest management activities to promote a sustainable supply and large, connected, and widely-distributed blocks of dense, young spruce-fir stands and to conserve large blocks of unfragmented forestland in northern and western Maine (MDIFW 2011, p. 3).

Unit 2: Northeastern Minnesota - Although lynx were unprotected and had a bounty placed on them in Minnesota prior to 1965, lynx trapping and hunting have been prohibited in Minnesota since 1984 (Moen *in* Lynx SSA Team 2016, p. 19). Overlapping the Northeastern Minnesota SSA unit, the State Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ) for which it has promulgated and enforces special trapping regulations for other furbearers in lynx habitat. The MNDNR has modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (pages 52-54 at: http://files.dnr.state.mn.us/rlp/regulations/hunting/2013/full_regs.pdf). In 2015, the MNDNR issued emergency trapping rules in the LMZ mandating additional restrictions on the types of traps that may be used (MNDNR 2015, entire) to further reduce the likelihood of incidentally trapping lynx. Minnesota DNR is under a federal court order to develop an incidental take plan for lynx and plans to seek an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping. Like Maine, Minnesota has a State Endangered Species Statute (84.0895) which requires the Minnesota DNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern (State of Minnesota 2015, entire). The Statute also authorizes the DNR to adopt rules that regulate treatment of species designated as endangered and threatened. Also like Maine,

Minnesota has designated the lynx a species of special concern (MNDNR 2013, p. 2), and coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats.

Unit 3: Northwestern Montana/Northeastern Idaho - Lynx are designated as a species of concern (S3) by the State of Montana and a species of greatest conservation need (S1) by by the State of Idaho (ILBT 2013, p. 57). The harvest of lynx was prohibited in Idaho and Montana beginning in 1996 and 1999, respectively. Both States participate in the CITES Export Program for bobcats, and both have promulgated and enforce special regulations for the legal trapping of other furbearers in areas occupied by lynx. In its trapping regulations, Idaho Fish and Game (IDFG) provides information on how to distinguish between bobcats and lynx and provides guidelines to reduce injury and minimize non-target catches, including lynx (IDFG 2016, pp. 36-37). Guidelines recommend (1) a minimum 8-pound pan tension on foothold traps set for wolves, (2) specific trap types and sets for other furbearers, and (3) bait and habitat considerations when making sets. Trappers are also required to contact IDFG or local sheriff's offices to assist with the safe release of incidentally trapped lynx. In response to a lawsuit after several lynx were incidentally trapped recently in northern Idaho, the U.S. District Court for the District of Idaho ordered the State to submit "a plan to protect the lynx from future incidental takes in the Panhandle and Clearwater (northern) Regions of Idaho" (U.S. District Court ID 2016, pp. 25-26). The plan has not yet been completed and negotiations between the State and the court are ongoing (Sallabanks 2016, pers. comm.). To minimize and track the incidental capture of lynx, Montana Fish, Wildlife, and Parks (MTFWP) has promulgated an evolving set of trapping regulations and reporting requirements since the DPS was listed (MTFWP 2016, pp. 7-10), including significant changes in 2008 that reduced the reported rate of incidental lynx captures from 1.6 per year in 2000-2007 to 0.4/year in 2008-2015 (MTFWP 2016, p. 5). In 2015, the Federal District Court of Montana approved a settlement agreement reached between the State of Montana and conservation groups aimed at protecting lynx from trapping. The case is now dismissed in accordance with the agreement, which requires Montana to implement a set of reasonable restrictions on trapping in lynx habitat. Currently, these regulations identify designated lynx protection zones (LPZs) and define acceptable trapping methods for public lands within them, which (1) prohibit the use of lethal (non-relaxing) snares for bobcats, (2) specifies the types of sets and baits or attractants that may be used for marten, fisher, and other furbearers where lynx occur, (3) requires a minimum 10-pound pan tension on foothold traps set for wolves, and (4) requires that any incidentally trapped lynx must be released unharmed if possible and reported to MTFWP (MTFWP 2016, pp. 7-10). MTFWP is also responsible for implementing Montana's Nongame and Endangered Species Conservation Act (http://leg.mt.gov/bills/mca/87/5/87-5-103.htm; https://www.animallaw.info/statute/mt-endangered-species-chapter-5-wildlife-protection#87-5-107).

Unit 4: North-central Washington - Lynx harvest was prohibited in Washington in 1991, and the lynx was listed as a State threatened species in 1993 and proposed for uplisting to endangered in 2016 (Lewis 2016, pp. *iii*, 1). Under the State's Endangered Species Program, the Washington Department of Fish and Wildlife (DFW) developed a Lynx Recovery Plan (http://wdfw.wa.gov/publications/00394/) and a Status Report

(http://wdfw.wa.gov/publications/01521/), and it prepares annual reports to update population and habitat information for the species. The DFW also coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats. Additionally, the use of body-gripping traps (foot-hold, conibear, snares, etc.) for trapping other furbearers is prohibited in Washington (except for damage control or nuisance wildlife, which requires special permits). This avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

Unit 5: GYA (Southwestern Montana and Northwestern Wyoming) - See Unit 3, above, for summary of Montana's special trapping regulations to minimize incidental take of lynx. Lynx in Wyoming were offered full protection from trapping and hunting beginning in 1973, and they are designated by the State as a species of greatest conservation need (ILBT 2013, p. 57). The Wyoming Game and Fish Department (WGFD) also participates in the CITES Export Program for bobcats.

Unit 6: Western Colorado - Lynx harvest was prohibited in Colorado in 1970 and the lynx was listed as endangered in the State in 1973. Colorado participates in the CITES Export Program for bobcats, provides information to trappers and hunters on how to distinguish between lynx and bobcats, and requires immediate release of uninjured incidentally trapped lynx as well as reporting of any (uninjured, injured, or killed) incidentally trapped lynx (CPW 2015b, pp. 6-7). Colorado law prohibits the use of foothold or conibear traps and snares for trapping, which avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

State Forest Management Regulations - Timber harvest and other forest management activities on State and private lands are governed by State regulations. Because these activities have the potential for beneficial, benign, or adverse impacts to lynx habitat depending on methods, implementation, and conservation measures, State forestry regulations may influence lynx populations, particularly where substantial amounts of lynx habitat occur on State and private lands. Below, we provide an overview of the forest management regulations in the SSA geographic units and briefly discuss their potential influences on lynx habitat. Additional details on the current and likely future influences of these regulations on lynx populations are provided below in chapters 4 and 5, particularly for the Maine and Minnesota units, where State and private lands constitute the majority of lynx habitats.

Unit 1: Northern Maine - State and private lands constitute 7 percent and 92 percent, respectively, of this SSA unit, with the vast majority of private lands managed for commercial timber production. As described above in section 2.3.2.2 and in more detail below in sections 4.1.1 and 5.1.1, the current abundance of lynx in northern Maine is attributable to the landscape-scale clear-cutting that occurred on private timber lands in the 1970s and 1980s in response to an extensive spruce budworm outbreak, which resulted in the recent unnaturally large amount of young (15 to 35 years post-harvest) regenerating forest in prime hare habitat condition. The amount and distribution of this post-clear-cut excellent hare habitat likely peaked in the late 1990s, when 20-25 percent of the forest in Maine was in an early regeneration stage - 3 to 8 times higher than historic conditions, when only 3-7 percent of stands were likely in such condition at any given time (68 FR 40094). Current timber harvest and management on State

and private lands in Maine are governed by the Maine Forest Practices Act of 1989 and administered by the Maine Forest Service within the Department of Agriculture, Conservation & Forestry to regulate the size, arrangement, regeneration, and management of clearcuts (MEDACF 2014, pp. 42-45). Under the Act, small (up to 250 acre) clear-cuts are still permitted, but require special permits. Because of this regulatory burden, the extensive clear-cutting of the past has largely been replaced by partial harvest techniques that are unlikely to maintain the current unnaturally high amount and distribution of high-quality hare habitat. The consequences of this shift in forest management on Maine's current lynx population, which is also much larger than was likely possible under the natural historic disturbance regime, are discussed below in sections 4.1.1 and 5.1.1, along with other programs that may influence private lands forest management in this unit.

In Maine, there are no long term management agreements in place on private lands to assure management of lynx. In 2006 and 2007, the Natural Resource Conservation Service (NRCS) provided funds to Maine for a pilot Healthy Forest Reserve Program (HFRP) specifically to manage for Canada lynx and American marten. Five landowners enrolled in the program, but one withdrew. The remaining four landowners were provided funding to develop lynx plans on a total of about 630,000 acres (about 10 percent of the critical habitat area). Landowners selected one or two township-sized (23,000 acre) areas within their ownerships to develop and implement a lynx management plan. Thus, about 161,000 acres within the larger area was targeted for managing lynx. All four landowners completed lynx plans using guidelines in the Service's *Canada lynx management guidelines for Maine* (McCollough 2007). NRCS contracts with the landowners last 10 years and will expire in 2016 and 2017. The HFRP described an opportunity for enrollees to apply for Safe Harbor Agreements when their contracts expired, although none have indicated an interest yet in doing so. Management plans were written for a 70-year period so some landowners may continue voluntary lynx management activities. Many private landowners in Maine are enrolled in forest certification programs; the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Both programs require landowners to protect endangered species and their habitats, but there are not specific recommendations pertaining to lynx. About 2.5 million acres in northern Maine is under conservation easement (http://web.colby.edu/stateofmaine2012/state-of-large-landscape-conservation-in-maine/ last accessed 8.18.2016), but easements require management prescriptions or commitments for Canada lynx. To our knowledge, there are no private landowners in Maine who have committed to long-term or permanent protection and creation of lynx habitat according to the Service's lynx management guidelines or LCAS.

State lands include Baxter State Park (~200,000 acres) and the various lots owned and managed by the Maine Bureau of Parks and Lands (MBPL). Most of Baxter State Park is managed as wilderness area, and lynx sightings in the Park are rare because most of the park is mature forest. MBPL integrated resource policy requires that they promote the conservation of federally listed species, but so far no lynx management plans have been developed. Mitigation for Maine Department of Inland Fisheries and Wildlife's incidental take permit for trapping requires management of 6,400 acres of lynx habitat within a 22,000-acre habitat management area on the MBPL's Seboomook Unit for a 15-year period.

Unit 2: Northeastern Minnesota - State and private lands constitute about 36 percent and 16 percent, respectively, of this SSA unit. The Minnesota Department of Natural Resources (MN DNR) Division of Forestry regulates timber harvest and management on State and private lands. Under the Sustainable Forest Resources Act of 1995 (revised most recently in 2014 [MFRC 2014a, p. 1]), the Minnesota Forest Resources Council (MFRC) has developed voluntary guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) that are intended for private and state landowners and include some general recommendations for wildlife including lynx. However, because they are voluntary, the extent to which these guidelines benefit lynx is uncertain (see sections 4.1.2 and 5.1.2 below).

Unit 3: Northwestern Montana/Northeastern Idaho - State and private lands constitute about 4 percent and 8 percent, respectively, of this SSA unit, and almost all are in Montana portion of the unit. The Montana Department of Natural Resources and Conservation (MTDNRC) administers several laws pertaining to forest practices on State and private lands. These laws are intended to protect streamside management zones, reduce fire hazards, and provide BMPs to minimize non-point source water pollution (http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices, accessed July 18, 2016). Although these laws may provide indirect benefits to lynx and other wildlife, they do not include specific measures to conserve or avoid impacts to lynx habitats. However, the MTDNRC and the Service collaborated on a multi-species habitat conservation plan (HCP) for forested State Trust lands that includes a Lynx Conservation Strategy to minimize impacts of forest management activities on lynx and describes conservation commitments that are based on recent information from lynx research in Montana (USFWS 2104, pp. 22-23; 79 FR 54835-54837). This HCP covers about 64 percent of the State lands in this SSA unit, regulates activities primarily associated with commercial forest management to conserve lynx foraging, denning, and connectivity habitats, and includes a 50-year commitment (79 FR 54835-54836). Additional details on this HCP and other programs for conserving lynx habitats on State and private lands in this unit are provided in section 4.1.3 below.

Unit 4: North-central Washington - State and private lands constitute about 8 percent and 0.3 percent, respectively, of this SSA unit.t, and most are State Trust lands in the Loomis State Forest, which accounts for all 426 km^2 (164 mi^2) of State lands in this unit. The Washington Department of Natural Resources (WADNR) administers rules guiding forest practices, such as timber harvests and road building, on State, private, and tribal forests in Washington. The Forest Practices Board, an independent state agency, adopts forest practices rules to protect water quality, fish habitat, other public resources and guide DNR's permitting process for timber harvests and other forest practices statewide. The WADNR developed a Lynx Habitat Management Plan (LHMP) for WDNR-managed lands distributed throughout north-central and northeastern Washington in areas delineated as Lynx Management Zones in the Washington State Lynx Recovery Plan (Stinson 2001; Washington DNR 2006). The WADNR LHMP guides timber harvest and other vegetation management on these lands, including the part of the Loomis State Forest that occurs in this unit, with the goal of creating and preserving quality lynx

habitat through its forest management activities. Additional information on the LHMP are provided in sections 4.1.4 and 5.1.4 below.

Unit 5: GYA - State and private lands constitute about 0.3 percent and just over 2 percent, respectively, of this SSA unit and, combined, likely have little influence on lynx population persistence. Forestry regulations for the Montana portion of this unit (26 percent) are described above. In the Wyoming portion (74 percent of the unit), the Wyoming State Forestry Division is responsible for the management of forested trust land across the state, including timber management and harvest, for long term forest health and productivity. Although the Division's programs may provide some indirect benefits to lynx, they do not include species- or habitat-specific regulations or conservations measures.

Unit 6: Western Colorado - State and private lands constitute about 0.6 percent and over 9 percent, respectively, of this SSA unit. The Colorado Department of Natural Resources and the State Division of Forestry oversee forest management activities on State and private lands in Colorado.

Tribal Management: Tribal lands encompassed by SSA geographic units include those of the Passamaquoddy Tribe and the Penobscot Indian Nation in Maine (248 km^2 [96 mi^2] in Unit 1), Grand Portage Band of Lake Superior Chippewa in Minnesota (202 km^2 [78 mi^2] in Unit 2), and the Confederated Salish and Kootenai Tribes of the Flathead Nation - Flathead Reservation in Montana (958 km^2 [370 mi^2] in Unit 3). Tribal management of these lands is expected to benefit lynx and lynx habitats. No tribal lands occur within SSA units 4, 5, or 6.

Unit 1: Northern Maine - Tribal lands represent less than 1 percent of this unit. The Passamaquoddy Tribe's stated environmental mission is "...to protect the environment and conserve natural resources within all Passamaquoddy lands, waters, and the air we share" (Passamaquoddy Tribe 2014, entire). That of the Penobscot Indian Nation Department of Natural Resources is "...to manage, develop and protect the Penobscot Nation's natural resources in a sustainable manner that protects and enhances the cultural integrity of the Tribe" (Penobscot Indian Nation 2014, entire). Hunting, trapping or possessing lynx are prohibited in accordance with the Penobscot Indian Nation Chapter VII Inland Fish and Game Regulations – Section 204 (Penobscot Indian Nation 2012, p. 15).

Unit 2: Northeastern Minnesota - Tribal lands of the Grand Portage Indian Reservation and the Bois Forte Indian Reservation—Vermillion Lake District represent 1 percent of this SSA unit. The Grand Portage Band of Chippewa has been actively working on lynx conservation since 2004. In October 2007, the Band hosted an international conference on lynx research and conservation where more than 50 researchers from the United States and Canada presented results of research on lynx diet, habitat, and management. Additionally, on-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire).

Unit 3: Northwestern Montana/Northeastern Idaho - Tribal lands of the Confederated Salish and Kootenai Tribes of the Flathead Nation, Flathead Reservation represent nearly 4 percent of this SSA unit. The mission statement of the Tribes' Fish, Wildlife, Recreation and Conservation Division is "...to protect and enhance the fish, wildlife, and wildland resources of the Tribes for continued use by the generations of today and tomorrow" (Confederated Salish and Kootenai Tribes 2014a, entire). An objective of the Tribes' Tribal Wildlife Management Program Plan is to ''. . . develop and implement habitat management guidelines for Canadian lynx in coordination with the Forestry Department as specified in the Forest Management Plan'' (Confederated Salish and Kootenai Tribes. 2014b, p. 5). The Forest Management Plan states that ''Standards for lynx management and habitat protection are set forth in the Canada Lynx Conservation Assessment and Strategy. This strategy guides land management activity in lynx foraging and denning habitat. Lynx occurrence and populations will continue to be monitored on the Reservation'' (Confederated Salish and Kootenai Tribes 2000, p. 285).

In summary, a variety of State wildlife and forestry regulations and conservation efforts, along with Tribal resource management objectives, influence activities in lynx habitats across the range of the DPS. While many of these clearly benefit lynx habitats and likely contribute to the persistence of resident populations, uncertainty remains regarding the effectiveness of some regulations and voluntary programs or measures in maintaining or restoring lynx habitats. This may be especially important with regard to timber management regulations and programs on private lands, which constitute the majority of lands in the Northern Maine geographic unit and a substantial amount of the Northeastern Minnesota unit.

3.2 Climate Change

In 2014, the International Panel on Climate Change (IPCC) released its Fifth Assessment Report, which represents the current scientific consensus on global and regional climate change and the best scientific data available in this rapidly changing field. The Fifth Assessment Report largely reaffirms the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere (IPCC 2014a, entire).

''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat

fragmentation) (IPCC 2007a, pp. 8–14, 18–19). In our analyses, we weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

The IPCC's Fifth Assessment Report concludes that the strongest and most comprehensive evidence of the impacts of climate change is in natural systems, where many species have responded by shifting their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC 2014a, p. 4). The report also concludes that projected climate change during and beyond the 21st Century will increase extinction risk for many terrestrial and freshwater species (IPCC 2014a, pp. 14–15). In North America, observed impacts attributable to climate change that may affect lynx habitats and distribution include upslope and northward shifts in species distributions across multiple taxa, and increased wildfire activity, fire frequency and duration in boreal and subarctic conifer forests of Canada and the western U.S. (IPCC 2014a, p. 31).

At the time of listing, the Service determined there was no evidence to support global warming as a threat to lynx (65 FR 16068-16069). In the 2003 remanded determination, we concluded that the best information available at that time regarding the potential impact of climate change on lynx (warming leading to long-term reductions in snow depths needed to support lynx in the eastern U.S. and eastern Canada south of the St. Lawrence Seaway; Hoving 2001, pp. 72-75) was speculative and did not demonstrate a threat to lynx (68 FR 40083, 40098). In the 2005 recovery outline for the DPS, the Service acknowledged that continued climate warming was likely to negatively affect the boreal forest ecosystem for which lynx are highly adapted, eventually causing it to recede north and/or to higher, colder elevations, potentially resulting in a substantial reduction or even elimination of lynx habitats from the contiguous U.S. (USFWS 2005, pp. 11, 14). In the 2009 critical habitat rule, the Service acknowledged that new science concerning climate change was available, and that climate change may pose a risk to the future conservation of lynx (74 FR 8617, 8621). In the 2014 revised critical habitat rule, we concluded that recent information on regional climate changes and potential effects to lynx habitat (e.g., Knowles *et al.* 2006, pp. 4545–4559; Carroll 2007, pp. 1098–1102; Danby and Hik 2007, pp. 358–359; Gonzalez *et al.* 2007, entire; Iverson *et al.* 2008, pp. 390–400; Beckage *et al.* 2008, entire; Burns *et al.* 2009, p. 31; Johnston *et al.* 2012, pp. 6–13) suggested that climate change is likely to be a significant issue of concern for the future conservation of the lynx DPS (79 FR 54811). Specifically, climate models project reductions in the extent of boreal forest habitats and snow conditions needed to support lynx throughout the DPS, with both features modeled to migrate to higher elevations (in locations where this is possible) and northward in latitude. This would result in fewer, smaller, and more fragmented and isolated areas capable of supporting resident lynx and, therefore, smaller and more isolated lynx populations that would likely be more vulnerable to stochastic environmental and demographic events (79 FR 54811). Climate change also may have synergistic effects with other stressors (e.g., forest insect outbreaks and wildfire frequency, size, and intensity) that could further reduce and isolate lynx populations within the DPS and reduce connectivity to lynx in Canada.

Lynx biologists identify climate change as the most important and overarching factor influencing resiliency of the DPS (Lynx SSA Team 2016, pp. 14, 17, 19, 21-22, 35-47, 50, 53-57; ILBT

2013, pp. 43, 48, 53, 55, 63, 66, 69-71, 98). Climate change is likely to be exacerbated at the southern edge of the range where habitat and snow conditions are patchy and becoming increasingly marginal for the continued existence of lynx (Gonzales *et al.* 2007, p. 8). Across North America, a significant increase in proportion of winter precipitation falling as rain rather than snow has resulted in reduced persistence of the winter snowpack (Dyer and Mote 2006, entire), increased snow density (Hodgkins and Dudley 2006, entire), and decrease in the extent of deeper snowpacks (Dyer and Mote 2006 p. 1, Brown 2000, pp. 2347-2354). Climate change models suggest that future snow cover in the contiguous U.S. will be further reduced in extent and distribution (McKelvey *et al.* 2011, pp. 2892-2896).

Warming and more frequent winter thaws are contributing to changes in snowpack structure, namely replacing deep, fluffy snow with harder, crustier snow, with these conditions occurring at higher latitudes (Callaghan *et al.* 2011, entire) and higher elevations in the Rockies (Abatzoglou 2011, pp. 1138-1141). The frequency of warm spells is correlated to the hardness of the snow surface, sinking depth, and the hunting efficiency of lynx (Stenseth *et al.* 2004, p. 10633). As the climate warms, winter temperatures are rising above freezing more often. This results in more rain on snow events and winter thaws that change the structure of the snowpack; larger grain size, basal ice layers, depth hoar (weak layers in the snowpack), and slip planes (crusts and ice layers within the snowpack) (Callaghan *et al.* 2011, p. 23). Hard snow surfaces (crust) and other structure in the snowpack are believed to reduce the competitive advantage of lynx over bobcats and other mesocarnivore competitors and predators.

Although it is believed that high elevation areas in the West may provide refugia for lynx (Lynx SSA Team 2016, p. 45), these areas will also be affected. Mountainous regions in the western U.S. have historically been strongly snow dominated from November through March. By 2050, the length of snowfall-conducive temperatures over many western mountain ranges will be reduced from approximately five (November–March) to approximately three (December-February) months of the year (Klos *et al.* 2014, p. 4566). Many relatively large areas that contain lower relief, mid-elevation mountain ranges will likely shift relatively quickly into new precipitation phase regimes (e.g., the Northern Rockies, North Cascades)(Klos *et al.* 2014, p. 4566). The interior northwestern U.S. shows a greater sensitivity of its strongly snow-dominated areas to warming because much of the region is characterized by relatively warm winter temperatures and by mainly mid-elevation mountain ranges. The climatic rain-snow transition zone will move up in altitude and latitude.

It is possible that in high elevation areas of DPS in the West, snow conditions suitable for lynx may move up slope at a faster rate than boreal forest habitat will migrate, providing a mismatch of these important habitat elements for lynx. During prehistoric periods of warmer climate, the alpine treeline ecotone (upper elevation of lynx boreal habitat) and deciduous-boreal forest ecotone (lower elevation of lynx boreal habitat) have readily moved upslope in both the northern (Kearney and Luckman 1983) and southern Rockies (Legg and Baker 1980). Boreal treelines in Scandinavia moved upslope an average of 40 m (but up to 100 m) during a recent 50-year period of warming (Kullman 1990). However, despite recent warming, the alpine treeline in North America has thus far remained relatively static (Butler *et al.* 1994). Upslope migration of

the treeline of boreal forest may be limited by high winds, desiccation, and soil depth not conducive to colonization by conifers and will occur either gradually or as a series of scattered, rapid advances as thresholds are crossed (Kupfer and Cairns 1996, p. 259-261). At lower elevations, the upslope movement of the deciduous-boreal ecotone is limited by an isocline of excessively cold winter temperatures (generally -40C), moisture (cloud, fog line), and acidic soils (Kupfer and Cairns 1996, p. 263-264). The rate that boreal forest will retreat upslope is highly speculative depending on how climate change will affect complex moisture and temperature regimes, and there could be a lag time before these community types move up slope (Kupfer and Cairns 1996, p. 268). In the Yukon, upslope migration of spruce-fir seemed to be triggered by climate thresholds and was characterized by slow, gradual change followed by rapid advances (Danby and Hik 2007, p. 361). However, in Vermont, the northern hardwood-boreal ecotone moved upslope 91 to 119 m between 1962 and 2005 consistent with rapidly increasing cloud ceilings in the Northeast, which is believed to be closely associated with this ecotone transition (Beckage *et al.* 2008, pp. 4200-4201).

In contrast, there have been no lag time or thresholds slowing changes in the precipitation and snow regime. Much of the Rockies have already experienced declines in spring snowpack in response to climate change, especially since midcentury, despite increases in winter precipitation in many places (Mote *et al.* 2005, entire; Scalzitti *et al.* 2016, pp. 5367-5368). Some mountainous regions are warming at a faster rate than global land averages (Rangwalla and Miller 2012, entire). It is likely that the losses in snowpack observed to date will continue and even accelerate (Hamlet and Lettenmaier 1999; Payne *et al.* 2004), with faster losses in milder climates like the Cascades and the slowest losses in the high peaks of the northern Rockies and southern Sierras. For every 1 °C increase in temperature, snowline increases about 150 m in elevation (Beniston 2016, p. 106). By 2100, the altitude above which it snows and below which it rains will climb as much as 800 feet in the Colorado Rockies, by 1,400 feet in the Rockies of Idaho and Wyoming, and the snow line will rise by an average of 950 feet across six Western mountain regions if greenhouse gas emissions continue at the current rate (Scalzitti *et al.* 2016, p. 1564). Thus, it is possible that boreal forest will persist for a while, but deep, fluffy snow conditions will retreat upslope and preclude the use of boreal habitat by lynx and instead favor competitors such as bobcats.

The effects of climate warming are already occurring and have accelerated over the past three to four decades (Hansen *et al.* 2006, entire). Globally, greenhouse gas emissions are increasing and tracking levels predicted by models for high emissions scenarios (e.g., RCP8.5) (Peters *et al.* 2013; Friedlingstein *et al.* 2014, p. 709, 712; Fuss *et al.* 2014, p. 851; IPCC 2013, p. 180, 187-189). Analysis of paleoclimate indicates 20th century warming is likely to have been the largest of any century within the last 1000 years (Folland *et al.* 2001, pp. 99-101). These changes are predicted to continue and accelerate under future climate scenarios (Hall and Fagre 2003, Fig. 7). The range of warming projected over this century runs from 3.6 °F (2 °C) to 10.8 °F (6 °C) for North America, with warming higher than this average in areas that are inland, northerly, or mountainous.

Climate change is manifested in different ways throughout the northern contiguous United States and the lynx DPS. To date, the observed and predicted increases in surface temperatures have been greatest in the northern Rockies and Northeast (much of the lynx DPS) than elsewhere in the contiguous United States (IPCC 2014, pp. 12, 61, Workshop Report 2016, pp. 14-15). Climate history and projections from regional climate models for regions associated with the lynx DPS units corroborate global models, and indicate that both eastern and western North America, including all portions of the lynx DPS, have warmed in the last century and are likely to warm 1.8 °F (1 °C) to 5.4 °F (3 °C) by the year 2050 (IPCC 2007b, p. 889). For example, in the Northern Rocky Mountains at Glacier National Park, mean summer temperatures have increased 3.0 °F (1.66 °C) between 1910 and 1980 (Hall and Fagre 2003, pp. 134–137) resulting in lower snowpack, earlier spring melt, and distributional shifts in vegetation (Hall and Fagre 2003, pp. 138–139; Fagre 2005, pp. 4–9).

Climate change is diminishing snow conditions (reduced depth, quality, persistence) considerably throughout the DPS. The strong warming in recent decades corresponded to a large decline in snow cover in North America, particularly in the mountains of the western U.S. (Mote *et al.* 2005, p. 47-48). In most mountain ranges, relative declines vary from minimal at ridgetop to substantial at snow line. Temperature has increased more in the winter than summer (Knowles *et al.* 2006), which has increased the amount of winter precipitation falling as rain instead of snow throughout the DPS (Feng and Hu 2007, entire; Knowles *et al.* 2006, entire, Huntington *et al.* 2004, entire). The rate of decline in the snowpack of the northern Rockies is unprecedented in the last 1000 years (Pederson *et al.* 2011, entire). An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13).

Climate change is expected to substantially reduce the amount and quality of lynx habitat in the contiguous U.S., with patches of high-quality boreal and subalpine forest habitat becoming smaller, more fragmented, and more isolated (Carroll 2007, pp. 1099–1100; Johnston *et al.* 2012, p. 11). Various forms of snow compaction and structure within the snowpack (see above) give a competitive advantage to bobcats and other predators/competitors with higher foot loading that would normally have difficulty traveling and hunting efficiently in deep, fluffy snow conditions (Murray and Boutin 1991, Murray *et al.* 1994, Kolbe *et al.* 2010). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103). These trends indicate the range of the lynx in the DPS is likely to contract as a direct result of climate change. Because of climate change and other stressors, lynx biologists believed that only one to three of the six units may persist to the end of the century (Lynx SSA Team 2016, p. 48).

Near-term effects of climate warming on lynx are more certain than long-term effects. Lynx experts anticipate a downward trend for the probability of persistence of lynx in all six geographic units primarily because of the effects of climate warming (Lynx SSA Team 2016, pp. 35-47). The rates of change and magnitude of effects of climate warming is difficult to predict. Climate change is anticipated to affect each unit differently as summarized below.

Climate change is affecting many of the requirements necessary for the continued existence of lynx in the DPS. Climate warming will continue to stress populations into the foreseeable future. Direct effects to lynx, hares, and their habitat that are occurring or can be reasonably anticipated include 1) range contraction, 2) reduction in the periodicity and amplitude of the hare cycle, 3) reduction in snow conditions necessary to give lynx a competitive advantage, 4) reduction in hare habitat quality and populations, 5) reduction in the amount of lynx and hare habitat in the U.S., 6) changes in the frequency and pattern of disturbance events, 7) introduction of disease and parasites, and 8) reduced gene flow. Synergistic effects between these factors and other stressors (e.g., forest management, trapping, development) may intensify their effects (Carroll 2007). Diminished snow, increasing drought and fire, and increased forest pests and disease are believed to currently be the most important stressors for lynx in the DPS, but it is possible that other pathways are, or may become, equally important. Over the next decades, southern lynx populations will continue to be affected by climate change and associated shifts in habitat, prey base, and competition. The extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in the contiguous U.S. (Murray *et al.* 2008).

Range Contraction in the DPS - In response to climate change, lynx range in the DPS is expected to contract from boreal habitat shifting to higher elevation (Danby and Hik 2007, pp. 360-362) and northward shifts in latitudinal distribution of boreal habitat and snow conditions (Sturm *et al.* 2001, pp. 342-342; Gonzales *et al.* 2010, pp. 761-766; Koen *et al.* 2015. p. 528; ILBT 2013, p. 69). For example, lynx distribution in southeastern Ontario has shifted northward >175 km over the past 40 years (Koen *et al.* 2014, pp. 757-758). Habitat patches will become smaller, more fragmented and isolated (Carroll 2007, pp. 1099-1100; Johnston *et al.* 2012, p. 11), bobcat distribution will expand northward (see below), and lynx will become more vulnerable to stochastic and environmental and demographic effects because of smaller population sizes and increased isolation.

Reduction in Periodicity and Amplitude of the Hare Cycle - Climate change influences ecological processes by altering large-scale climate systems such as the North Atlantic Oscillation, Southern Oscillation, Pacific North American Index, and North Pacific Index which, in turn, affect patterns of temperature and snow in North America (Stenseth *et al.* 2003, entire). Climate change-induced disruptions are believed to have caused the collapse of cycles in voles, lemmings, and snowshoe hares (Ims *et al.* 2008, p. 81; Cornulier *et al.* 2013, entire; Krebs *et al.* 2010, pp. 484-488). The geographical borders between cyclic and noncyclic populations are shifting, and the spatial extents of regions that have cycles are shrinking. The collapse of cycles in herbivores with high-amplitude population cycles also would imply collapses of important ecosystem functions such as pulsed flows of resources and disturbances throughout the

ecosystem, including declines in predator communities (Schmitz *et al.* 2003, p. 1202; Ims *et al.* 2008, p. 85). A common denominator of cycles that exhibit spatial gradients, such as the more pronounced snowshoe hare cycles in the northern part of its North American range, is that the cycles seem to fade as winters become shorter (Ims *et al.* 2008, p. 81).

Changes in large-scale climate systems have already influenced the climate and snow conditions throughout the geographic range of the lynx in North America (Stenseth *et al.* 1999, entire; Krebs *et al.* 2001a, p. 34; Brown 2000, pp. 2347-2354). Yan *et al.* 2013 (p. 3269) provide the first evidence of the negative effects of climate warming on hare-lynx cycles in Canada. The authors concluded that climate forcing is not only essential in producing sustained cycles, but is also essential in modifying the cycle intervals (Yan *et al.* 2013, p. 3269). Collapses in lynx fur harvests in Canada beginning in the mid-1980s may be linked to warming (Yan *et al.* 2013, p. 3269). With more pronounced troughs in hare abundance cycles, lynx populations will decline (Hone *et al.* 2011, p. 424). Diminished lynx populations in the core of the range in Canada is a concern because most of the populations of lynx in the DPS are believed to be dependent on periodic immigration from Canada for demographic persistence and genetic stability (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789, 68 FR 40091, 40097-40100). If diminished amplitude of the hare cycle in Canada continues, it will likely translate into a reduced potential for lynx to expand into new or unoccupied habitat in Canada or the adjoining U.S. (ILBT 2013, p. 69).

Reduction in Snow Conditions that are Necessary to Provide Lynx a Competitive Advantage - Climate-induced changes in snow depth and quality are critical because they reduce the extent of deep, fluffy snow habitat available to lynx (Knowles *et al.* 2006, p. 4557; Carroll 2007, p. 1103; McKelvey *et al.* 2011, pp. 2893-2895; Lynx BioTeam 2012 p. 69; Gonzales *et al.* 2007, pp. 7-8). Across their worldwide distribution, lynx rely on deep, powdery and persistent snow because they restrict potential lynx competitors such as bobcat or coyote and predators such as fishers and cougars from effectively encroaching on or hunting hares in winter lynx habitat (Peers *et al.* 2016, entire; 79 FR 54809).

Warmer winter temperatures are reducing snowpack in all portions of the lynx DPS through a combination of a higher proportion of precipitation falling as rain and higher rates of snowmelt during winter (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Hoving 2001, pp. 73–75; Mote 2003, p. 3–1; Christensen *et al.* 2004, p.347; Knowles *et al.* 2006, pp. 4548–4549). These trends are expected to continue with future climate warming (Hamlet and Lettenmaier 1999, p. 1611; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 48; IPCC 2007b, p. 850). The IPCC (2007b, p. 850) concludes that ''snow season length and snow depth are very likely to decrease in most of North America except in the northernmost part of Canada where maximum snow depth is likely to increase.'' Shifts in the timing of the initiation of spring runoff toward earlier dates in western North America are also well documented (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Cayan *et al.* 2001, pp. 409–410; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 41; Knowles *et al.* 2006, p. 4554). In addition, a feedback (albedo) effect is accelerating the rate of loss of snow cover because of the reflective

nature of snow and the relative heat-absorbing properties of non-snow-covered ground. This feedback effect causes the greatest warming to occur at the interface of snow-covered and exposed areas, increasing the rate at which melting occurs in spring (Groisman *et al.* 1994a, pp. 1637–1648; Groisman *et al.* 1994b, pp. 198–200). This effect has led to the average date of peak snowmelt to shift 3 weeks earlier in spring in the Intermountain West (Fagre 2005, p. 4). This albedo effect is further exacerbated by atmospheric soot and desert dust on snow ((Qian *et al.* 2009, entire; Painter *et al.* 2007, entire) and fire-darkened landscapes (Amiro *et al.* 2006, pp. 47-49). Snow accumulation and duration are expected to decline generally in the geographic areas that contain the central and eastern portion of the lynx DPS (IPCC 2007c, p. 891; Burns *et al.* 2009, p. 31). Because lynx require prolonged periods of deep fluffy snow, current habitats that lose this feature would decline in value for lynx (Hoving 2001, p. 73; Carroll 2007, p. 1092; Gonzalez *et al.* 2007, entire).

Reduced snow depth and duration may reduce lynx's competitive advantage over bobcats, which have similar ecology to lynx but are not as well-adapted to hunting hares in deep fluffy snow (Hoving 2001, pp. 23–24; Carroll 2007, p. 1102; ILBT 2013, pp. 69, 71). The bobcat is the closest related species to lynx in North America, and it outcompetes or displaces lynx wherever the two species overlap, at both broad (Peers *et al.* 2016, entire) and local (Parker *et al.* 1983, Robinson 2006, pp. 120-129) geographic scales. In areas where they do overlap, lynx are subjected to niche displacement to habitats of inferior quality, which probably limits lynx survival and productivity at the southern edge of their range (Peers *et al.* 2016, entire; Robinson 2006, pp. 120). Snow depth likely acts as a mediator of competition between the two species. Bobcats have a higher foot loading than lynx, are unable to hunt hares successfully in areas with deep, soft snow (Krohn *et al.* 2005, pp. 122-129, Hoving *et al.* 2005, entire), and experience high mortality in deep snow winters (Litvaitis *et al.* 1986, p. 116). Lynx have a low foot loading and long legs (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, pp. 122-129) that gives them a competitive advantage over bobcats in deep, fluffy snow conditions. This has important implications for lynx persistence and range distribution at the southern edge of their range considering the current and projected changes in snow cover, stable or increasing bobcat populations in the DPS (Roberts and Crimmins 2010, p. 170), and the predicted northward expansion of bobcats into areas currently occupied by lynx (Lavoie *et al.* 2009, pp. 873-874; Roberts and Crimmins 2010, p. 172; Anderson and Lovallo 2003, p. 758).

Buskirk *et al.* (2000a, entire) described exploitation (competition for food) and interference (avoidance) competition from bobcats and other species that may compete with lynx. Exploitation competition could contribute to lynx starvation and reduced recruitment. Of several predators examined (raptors, coyote, gray wolf, cougar, bobcat, and wolverine), coyotes were deemed the most likely to pose local or regionally important exploitation impacts to lynx. Coyotes, bobcats, and cougars are possibly capable of imparting interference competition effects on lynx. Interference would be most probable during summer and during winter in areas lacking deep, unconsolidated snow (ILBT 2013, p. 36). Cougars are also predators of lynx in the West (ILBT 2013, p. 35), but, like bobcats, cougars also have high foot loading, which limits their efficiency in deep, fluffy snow (Buskirk *et al.* 2000a, p. 90). Fishers are predators of lynx in

Maine (Vashon *et al.* 2012), but their distribution and movements in winter are also limited by deep, unconsolidated snow (Krohn *et al.* 2004, entire).

The effects of lynx-bobcat hybridization on lynx populations in the DPS are uncertain. Bobcats have hybridized with lynx in Minnesota, Maine, and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where low topographic relief and variability in winter severity may allow more interaction between the two species during the breeding season (ILBT 2013, p. 34). Hybrids were capable of reproducing successfully (Homyack *et al.* 2008, p. 507). The hybridization rate is currently low between the species (0.24 percent) but could increase as bobcat populations move north with climate change (Murray *et al.* 2007, p. 1465; Koen *et al.* 2015, p. 528).

Reductions in Hare Populations - In addition to affecting the synchronicity and amplitude of hare cycles, climate change will likely affect hare populations in several different ways, especially at the southern extent of the range. Changing snow conditions may influence lynx hunting behavior and effectiveness. For example, hard-packed snow is reported to be associated with a higher kill rate of hares by lynx and coyotes than soft snow (Stenseth *et al.* 2004, p. 10633, Buskirk *et al.* 2000, p. 94). The higher kill rate could generate a numeric response by lynx and other hare predators (Hone *et al.* 2011, p. 420) that could drive hare populations to lower levels (Stenseth *et al.* 2004, p. 10633). Predator communities are more diverse at the southern part of the lynx range than in central Canada (Murray *et al.* 2008, pp. 1464-1465). The diverse predator community could explain why hare populations have declined and seem to remain low in Maine (Scott 2009, p. 43). Climate change will cause increased annual precipitation, periods of drought and extreme precipitation, and hotter summers across the northern tier of U. S. (i.e., throughout the DPS) in eastern North America (Jacobson *et al.* 2009, pp. 14-15, Romero-Lankao 2014, pp. 1452-1456). Increased precipitation may reduce hare numbers because the second litters of snowshoe hares have lower survival in wet summers (Meslow and Keith 1971, entire). However, because hares have two to four litters per summer, there is opportunity for compensatory survival of later litters if one is affected by weather (Krebs *et al.* 2014, p. 1043). Decreased hare survival may also be expected during prolonged hot, dry summer conditions. For example, hare densities in the GYA are believed to be low, in part, because of the dry conditions there (Hodges *et al.* 2009, p. XX). In dry western forests like those in the GYA, increased precipitation may result in more herbaceous forage and cover, which may promote hare survival and reproduction (Ivan *et al.* 2014, p. 590). Thus, climate change may have both positive and negative effects on hares.

Finally, the shorter duration and diminished snow cover in the DPS is causing an increasingly pronounced mismatch in the phenology of hare pelage change that may reduce hare survival (Zimova *et al.* 2013, entire; Mills *et al.* 2013, entire; 2014, entire). Diminished snow duration by as much as 8 weeks by the end of the century could have population-level effects on hares at the southern edge of their range. Hares exhibit plasticity in the rate at which they can molt from white to brown in the spring, but not in the initiation date of color change or the fall transition from brown to white (Mills *et al.* 2013, pp. 7362-7363). Hares do not seem to compensate for mismatched pelage by changing their behavior related to concealment, thus predisposing them

to predation (Mills *et al.* 2014, entire). There is wide variability in the timing of pelage change by individual hares within populations, and “mismatched” hares experience increased mortality rates (Zimova *et al.* 2016, p. 302). Under high emission scenarios, this could lead to an 11 percent decline in hare survival by mid-century and a 23 percent decline by late century. Diminished survival would lead to steep (high emissions) to moderate (medium-low emissions) declines in hare populations (Zimova *et al.* 2016, p. 304). It is also possible that this phenological mismatch may dampen hare cycles (Zimova *et al.* 2016, p. 305). Snow patterns have been proposed to potentially play a role in dampening cycles (Cornulier *et al.* 2013, pp. 64-65, Sultaire *et al.* 2016a, entire).

The range of the snowshoe hare is contracting northward in the southern part of its range in the contiguous U. S. because of changing snow conditions and reduced survival because of delayed pelage changes (Diefenbach *et al.* 2016, p. 245; Sultaire *et al.* 2016a, entire). In Wisconsin, snowshoe hare range has been contracting northward an average of 8.7 km per decade and will continue to recede northward with climate change (Sultaire *et al.* 2016a, entire). Loss of snow now contributes more than loss of habitat in determining the range of snowshoe hares in the Great Lakes region (Sultaire *et al.* 2016a, entire).

Reduction in Lynx and Hare Habitats - Climate change will diminish the amount of lynx habitat throughout the DPS by a) reducing the areas where snow conditions give lynx a competitive advantage over bobcats and other species, and b) reducing the amount of spruce-fir habitat required by snowshoe hares. An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Areas of contiguous spring snow cover will become smaller and more isolated throughout the Columbia, Upper Missouri, and Upper Colorado Basins, with greatest losses at the southern periphery, which likely is an indicator of the trajectory of lynx habitat (McKelvey *et al.* 2011). Deteriorating snow conditions caused by climate change is causing range contraction of snowshoe hares and the southern edge of their range (Sultaire *et al.* 2016b, pp. 900-904). Similarly, because of diminishing snow resources, potential lynx habitat is diminishing in the northern Appalachians and small areas in the Canadian Maritime Provinces (Carroll 2007, p. 1093).

Changes in temperature and rainfall patterns are expected to shift the distribution of ecosystems northward and up mountain slopes (McDonald and Brown 1992, pp. 411–412; Danby and Hik 2007, pp. 358–359; IPCC 2007c, pp. 230, 232). As climate changes over a landscape, the ecosystems that support lynx are likely to shift, tracking the change of temperature, but with a time lag depending on the ability of individual plant and animal species to migrate (McDonald and Brown 1992, pp. 413–414; Hall and Fagre 2003, p. 138; Peterson 2003, p. 652). On the basis of the best existing data for 130 tree species in North America and associated climate information, and assuming no limitations to individual tree growth, McKenney *et al.* (2007) predicted that the average range for a given tree species will decrease in size by 12 percent and will shift northward by 700 kilometers (km) during this century. In the contiguous U.S., researchers expect that lynx in mountainous habitat will, to some extent, track climate changes

by using higher elevations on mountain slopes, assuming that vegetation communities supportive of lynx and hare habitats also move upslope (Gonzalez *et al.* 2007, p. 7). Some areas of the DPS (e.g., Maine, Minnesota) lack elevational refugia and, therefore, lynx populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102).

These studies predict lynx and hare habitats—boreal spruce-fir and subalpine forests—and, therefore, lynx distribution, are likely to shift upward in elevation within its currently occupied range and recede northward as temperatures increase (Gonzalez *et al.* 2007, pp. 7, 13–14, 19; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, pp. 26–27, 30–31; Vashon *et al.* 2012, pp. 60, 64; ILBT 2013, p. 69). Lienard *et al.* (2016, p. 7) assessed forests in New England, Northern Great Plains, and higher elevations in the Rockies, including spruce-fir types, as vulnerable to drought-related stress from climate change during the next century. The boreal spruce-fir forests that provide habitat for lynx and snowshoe hares are thought to be limited by summer temperatures and drought (Iverson and Prasad 2001, pp.192–196) and, under a suite of emissions and climate change scenarios, are projected to diminish dramatically or disappear from much of the eastern U.S. (Iverson and Prasad 2001, p. 196; Iverson *et al.* 2008, pp. 390–400). Within the last 20 to 25 years, widespread mortality and reduced growth in red spruce in the Northeast are believed to be linked to climate stress (McLaughlin *et al.* 1987, p. 501, Johnson *et al.* 1988, p. 5373.). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103).

Climate change is disproportionately affecting the boreal forest in Canada, the source of lynx dispersing into the DPS. Arctic and alpine ecosystems are among the most sensitive to climate warming (Diaz and Eischeid 2007, entire). Boreal forests have been identified as a critical “tipping element” of the Earth's climate system and are believed to be more sensitive to drought than other forests (Lenton *et al.* 2008, pp. 1788, 1791). Studies suggest a threshold for boreal forest dieback of ~ 3 °C global warming (Lucht *et al.* 2006, entire, Joos *et al.* 2001, entire). Global temperatures are increasing and snowfall is declining at the fastest rate in higher latitudes within the boreal forest region of Canada and Eurasia (IPCC 2007). Predicted changes to the boreal forest are already occurring, and much of the climate-induced change is occurring faster than originally predicted, suggesting rapid change as opposed to slow linear change (Soja *et al.* 2007, pp. 5-6). General circulation models are in agreement that winter warming across the circumboreal region will be in excess of 40 percent above the global mean (Soja *et al.* 2007, p. 4). Increases in precipitation are expected in the boreal region of Canada, particularly during the winter, but may be offset with increases in summer drought, heat stress and evapotranspiration (Stocks *et al.* 1998, entire). Thus, boreal forests are experiencing rapid increases in tree mortality (Peng *et al.* 2011, entire). Several authors have suggested that grasslands, aspen parklands, and temperate forest will expand northward resulting in decreases in boreal forest (Rizzo and Wiken 1992, p. 50; Starfield and Chapin 1996, entire; Rupp *et al.* 2000, entire), which could further fragment spruce-fir habitat (Iverson *et al.* 2008, p. 404; Tang

and Beckage 2010, pp. 152-156; Simons-Legaard *et al.* 2016, p. 5; Rustad *et al.* 2012, p. 15). Climate change is expected to further fragment boreal forest in southern Canada (Hogg 1994, entire) and would reduce habitat connectivity between lynx populations in the contiguous U. S. and southern Canada.

Changes in the Frequency and Pattern of Disturbance Events – The distribution, amount, and composition of lynx habitat could be rapidly and dramatically altered by an increasing occurrence and persistence of drought, along with associated outbreaks of insects and pathogens, wind and ice storms, and wildfires (ILBT 2013, p. 70). All of these factors are potentially interrelated with multiple feedback mechanisms, and some have a cascading effect (Dale *et al.* 2001, p. 729). For example, drought can weaken trees, increasing their vulnerability to insects and pathogens. Insects and pathogens can create dead trees or increase fuel loads, potentially increasing the risk and intensity of fire. The boreal forest is a complex and variable system, and these effects are expected to vary in time and space. Climate change may compound these complex interactions into new domains that may be unprecedented and unpredicted (Dale *et al.* 2001, p. 729). These interactions may appear slowly and be difficult to detect because trees live for so long or they be manifested quickly after a catastrophic perturbation to the forest.

Climate change-induced drought and heat stress have already affected temperate and boreal forest (Allen *et al.* 2010, entire), particularly in the West where tree mortality rates have increased rapidly in recent decades (van Mantgem *et al.* 2009, entire). Droughts occur irregularly in forests in eastern North America and the Pacific Northwest, annually at the end of the growing season in forests at the midcontinental prairie–forest border, and annually in summer in western interior dry forests that depend on winter precipitation (Dale *et al.* 2001, p. 727). Increase in growing-season temperature could increase evaporative demand, triggering moisture stress. Under several climate scenarios, future increases in drought stress are expected in the Southern Rockies and parts of the Northwest (Dale *et al.* 2001, p. 727). The Great Lakes region and parts of the Northwest could experience drought stress within two decades, even though these regions may become wetter in later decades (Dale *et al.* 2001, p. 727).

The frequency of wildfire is increasing in boreal forests of North America. Extended fire seasons and increases in the total area burned are anticipated in the western U.S. with continued climate warming (McKenzie *et al.* 2004). Evaluating wildfire patterns in the western U.S. from 1970-2004, Westerling *et al.* (2006, entire) found rapid and dramatic increases in the frequency of large fires, wildfire durations, and the length of the wildfire season beginning in the mid-1980s. Mesic, middle- and high-elevation forest types (such as lodgepole pine and spruce-fir) in the northern Rocky Mountains experienced the greatest increases. Increased spring and summer temperatures and an earlier spring snowmelt strongly influenced large wildfires, suggesting that climate is the primary driver of these changes rather than fire exclusion (suppression), which appears to have had little impact on natural fire regimes of these higher-elevation forest types in this area ILBT 2013, p. 70).. In contrast, climate change is increasing precipitation in boreal forest regions of eastern North America, which has reduced wildfire frequency (Bergeron *et al.*

2001, p. 388). Under multiple climate scenarios, large increases in fire frequency are expected for boreal forest in central and western Canada, and reduced frequency in eastern Canada - a situation that reflects past Paleoclimates that were warmer than the present (Flannigan *et al.* 2001, pp. 860-862). Increased fire frequency at the grassland – aspen parkland – boreal forest transition in western Canada may hasten the conversion of boreal forest to aspen parkland and aspen parkland to grassland (Flannigan *et al.* 2001, p. 860-861), which could affect connectivity and gene flow in lynx populations.

Warmer springs could increase the frequency and duration of wildfires, which in turn could increase vulnerability of surviving trees to bark beetle attack (Westerling *et al.* 2006; ILBT 2013, p. 70). Increasing temperatures and forest homogeneity could create conditions favorable for bark beetle outbreaks that exceed natural disturbance thresholds, perhaps increasing the likelihood of additional outbreaks in the resulting large areas of even-aged forests (Raffa *et al.* 2008; ILBT 2013, p. 70).

Climate change is dramatically affecting the frequency and intensity of some eruptive boreal forest insect pests and pathogens that affect disturbance patterns in spruce-fir forests. Changes in temperature and precipitation affect herbivore and pathogen survival, reproduction, dispersal, and distribution. For example, native bark beetles, such as the spruce beetle and mountain pine beetle, are key agents of change in coniferous forest ecosystems in western North America and have recently defoliated millions of hectares – among the largest and most severe in recorded history (Bentz *et al.* 2009). Drought-stressed conifers have increased vulnerability to insect attack. By the end of the century, changes in temperatures across the boreal forests of western North America may cause markedly high probability of outbreak of these species (Bentz *et al.* 2010. pp. 607, 609). In contrast, the range of the spruce budworm, a major pest of spruce-fir ecosystems in eastern North America, is expected to shift northward reducing vulnerability of spruce-fir forests in Maine and Minnesota (Regniere *et al.* 2010, entire). However, widespread clearcutting following the most recent spruce budworm outbreak in Maine was the primary driver creating widespread lynx habitat (Hoving *et al.* 2005, Vashon *et al.* 2012).

Introduced species can affect forests through herbivory, predation, habitat change, competition, alteration of gene pools via hybridization with natives, and disease (as either pathogens or vectors) and can alter the diversity, nutrient cycles, forest succession, and fire frequency and intensity of some ecosystems (Dale *et al.* 2001, p. 727). Climate change will modify the distributions of many introduced species. Currently, there are few exotic species in North American boreal forests. This is likely because remote areas with little human intervention receive fewer exotic species. However, exotic species could be introduced in the future as boreal systems are increasingly exploited for forest products, mining, energy production, and other natural resources (Schinder and Lee 2010, entire).

Ice storms occur throughout the northern U.S.but are most frequent in the Northeast (Dale *et al.* 2001, p. 728). For example, in January, 1998 a severe ice storm extensively damaged the canopy of many northeastern U.S. and eastern Canadian forests, causing moderate to severe forest damage to over 10 million acres in the Northeast U.S. and southern Quebec (Irland 2000,

entire; Millward and Kraft 2004, entire; Jones and Mulhern 1998, p. 19). Ice storm damage to stands can range from light and patchy to total breakage of all mature stems over extensive areas (Irland 2000, entire). It is uncertain how climate change will affect the frequency, intensity, location, and extent of ice storms; however, atmospheric warming will most likely shift the locations of prevailing ice storms northward.

Introduction of Lynx or Hare Disease and Parasites - Climate change can increase pathogen development and survival rates, disease transmission, and host susceptibility, and some species are predicted to experience more frequent or severe disease impacts with warming while others may be relieved of pathogens (Harvell *et al.* 2002, entire, Harvell *et al.* 2009, entire). Climate change is likely to cause major changes to the geographic range and incidence of insect and tick-borne diseases (Daszak *et al.* 2000).

No apparent climate-influenced parasites or diseases have been identified that would affect Canada lynx or snowshoe hares, but experts believed this was difficult to predict and a possibility (Lynx SSA Team 2016, pp. 27, 37-39). A few pathogens have been documented in lynx in the DPS. For example, plague, a flea-borne disease caused by the bacterium *Yersinia pestis*, which is not native to North America, was reported for the first time in lynx in Colorado (Wild *et al.* 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 lynx released in Colorado between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to *Y. pestis*; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado. Exposure of some lynx to feline parvovirus was detected in six areas in western North America (Montana-Alaska)(Biek *et al.* 2002). *Troglostongylus wilsoni* is a nematode that infects the lungs of lynx and bobcats (Sarmiento 1956, Van Zyll de Jong 1966, Kumar 1974, and Reichard 2004) and was detected in Maine lynx (Vashon *et al.* 2012, p. 24). Lynx with heavy infestations have difficulty breathing and succumb to starvation, as occurred with several Maine lynx (Vashon *et al.* 2012, p. 24).

Reduction in Gene Flow - Koen *et al.* (2014, entire) hypothesized that climate change would create increasingly unsuitable environmental conditions for lynx (e.g., milder winters with reduced snow quality, declining and fragmented boreal forest), which was associated with low genetic diversity and high genetic differentiation at the trailing (southern) edge of the range. Furthermore, high winter temperature, low snow depth, and low proportion of suitable habitat were strongly correlated with neutral genetic diversity, low allelic richness, and high genetic differentiation (Koen *et al.* 2014, p. 757). The authors surmised that genetic structuring in southern lynx populations could be caused by a northward shift in optimal conditions, resulting in isolation and extirpation of lynx populations at the trailing edge of their range or climate-induced changes in the distributions of snowshoe hare or bobcats causing lynx to shift northward. Lynx with the greatest allelic richness were found in areas with the deepest snow in the core of their range in northern Ontario (Koen *et al.* 2014, p. 758). The authors concluded that climate warming has reduced gene flow at the receding (southern) edge of the lynx's range, and that southward gene flow from Canada into threatened U.S. populations is unlikely (Koen *et al.* 2014, p. 760). Stenseth *et al.* (2004, entire) documented population and genetic structuring in the lynx populations east and west of Hudson Bay based on differences in snow conditions on

either side of this divide. This may be explained by the reluctance of lynx to disperse between areas having different snow regimes and snow quality. Snow conditions may be the key factor in the spatial, ecological, and genetic structuring of Canada lynx (Stenseth *et al.* 2014, pp. 10633-10644).

Climate warming may further isolate lynx populations, thus reducing gene flow, by reducing connectivity between populations. For example, gene flow between eastern Canada and Maine lynx populations depends on an ice bridge for dispersal across the St. Lawrence River. Although some lynx currently cross the river, Koen *et al.* (2014, entire) found genetic structuring on either side of the river. Thus, the river already restricts gene flow. Climate-induced deteriorating ice conditions on the St. Lawrence River could further restrict gene flow between lynx populations north and south of the river (Koen *et al.* 2014, p. 528). Between 1969 and 2002 there was a 20 to 40 percent reduction in sea-ice cover during the spring thaw in the Gulf of the St. Lawrence (Johnston *et al.* 2005). Conversely, reduced ice on the St. Lawrence may prevent bobcats from dispersing northward into lynx areas in central Quebec (Koen *et al.* 2014, p. 528).

3.3 Vegetation Management

Forest management occurs across the range of the lynx and can directly affect important habitats and prey. At the time of listing, management activities uninformed by consideration of negative impacts to the species were identified as being of greatest potential concern to lynx conservation (68 FR 40076-40101). Forest management is the most prevalent land use throughout the lynx DPS and can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitat and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Forest management affects stand structure, composition, and arrangement on the landscape, which are important elements of habitat for snowshoe hares and lynx. At the home range scale, lynx throughout the DPS select landscapes having the greatest snowshoe hare densities. In Maine and Minnesota these are young, regenerating spruce-fir forests (Hoving *et al.* 2004, McCann and Moen 2011) and in the West regenerating lodgepole pine (Koehler, Maletzke, Berg *et al.* 2012) and dense mature conifer forest, as well as young stands with dense spruce-fir saplings (Griffin 2004, Squires *et al.* 2010, pp. 1648, 1653–1656; Berg *et al.* 2012). Silvicultural prescriptions and cutting practices in boreal forest types vary widely throughout the lynx DPS depending on the landowner, forest ecology and ecoregion, tree species, site conditions (e.g. moisture, slope, aspect), disturbance regimes (e.g., fire, insect outbreaks), forest policy and regulations, logging equipment, and markets for forest products. Forest management that creates habitat for hares and lynx in one geographic area may not be beneficial to hares and lynx in another.

Nevertheless, snowshoe hares throughout the DPS range respond to one common denominator. Dense understory (horizontal cover) is the most important forest structural characteristics for hares throughout their range (Ferron and Ouellet 1992, Wolfe *et al.* 1982, Litvaitis *et al.* 1985). Dense, horizontal cover provides hares with a source of browse and cover from predation. Softwood (e.g., spruce-fir) has about three times more cover value than hardwoods (Litvaitis *et al.* 1985). Thus, stem density (or stem cover units) and snowshoe hare

density are directly and positively correlated (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Koehler and Brittell 1990, Thomas *et al.* 1997, Hodges 2000a, Mowat *et al.* 2000, Homyack *et al.* 2006, Robinson 2006, Scott 2009, Fuller and Harrison 2013). Forest practices that promote high stem density and dense horizontal cover can increase snowshoe hare densities (Keith and Surrendi 1971; Fox 1978; Conroy *et al.* 1979; Wolff 1980; Parker *et al.* 1983; Livaitis *et al.* 1985; Bailey *et al.* 1986; Monthey 1986; Koehler 1990a, b; Robinson 2006; Fuller *et al.* 2007; Homyack *et al.* 2007; Scott 2009; McCann and Moen 2011). Forest practices that reduce dense understory generally reduce habitat quality for hares and lynx.

Effects of forest practices on snowshoe hare habitats have been studied across the range of the species (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Thomas *et al.* 1997, Homyack *et al.* 2005, Robinson 2006, Griffin and Mills 2007, Scott 2009, Berg 2010, Ivan 2011a, Lewis *et al.* 2011, McCann and Moen 2011). Similarly, the effects of forest management on lynx habitat use, movements, and home range have been investigated by Koehler (1990a), Koehler and Brittell (1990), Fuller *et al.* (2007), Homyack *et al.* (2007), Moen *et al.* (2008), Vashon *et al.* (2008b), Simons (2009), Squires *et al.* (2010), Simons-Legaard *et al.* (2013), Simons-Legaard *et al.* (2016).

Historically, the dominant natural disturbance processes that created young, regenerating conifer forest conducive to hares and lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of northern Maine, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S. After disturbances, forests generally develop through several stages described by Oliver (1980) as “stand initiation,” “stem exclusion,” “understory reinitiation,” and “old growth.” Stand dynamics, particularly within-stand competition for light, nutrients, and space, determine how forests grow and respond to intentional manipulations and natural disturbances (Oliver and Larson 1996). The frequency and severity of disturbances have a large role in determining which species will dominate in a stand after the disturbance event. Snowshoe hare and lynx habitat are created during the stand initiation stage, after the young trees have established and grown tall enough (1-3 meters) to protrude above the snow and provide adequate horizontal cover. During the stem exclusion stage (~10 meters depending on tree species) the tree crowns lift and lower branches self-prune, thus reducing the live horizontal branches providing food and cover for snowshoe hares. In the old growth stage, understory may re-develop (e.g., in forest gaps where mature trees die or fall down) and food and cover may again become available to support snowshoe hares.

Commercial timber management of conifer forests traditionally has been designed to: in very young, regenerating forest to select for desired species (e.g., herbiciding, plantations) and reduce tree density to promote tree growth (e.g., precommercial thinning); in young middle-aged forest to improve growth and vigor of mature trees (e.g., commercial thinning, pruning, thinning from below); and in mature forest to reduce the vulnerability of commercially valuable trees to insects, disease, and fire (e.g., commercial thinning, group selection, fuels reduction). The

culmination of the process (or a forest rotation) is harvesting of forest products. Just as the timing and intensity of a natural disturbance affects the composition of the succeeding forest, the season, climate, machinery, and type of final harvest (e.g., clearcut v. partial harvest) have a large role in determining the species composition and health of the next crop of trees. Timber management practices may mimic natural disturbance processes but often are not an exact ecological substitute. Some practices, such as use of herbicides to suppress hardwood regeneration or plantations do not have an historical analogue. Timber harvest may differ from natural disturbances by:

- Removing most standing biomass from the site, especially larger size classes of trees, and down logs, which alters microsite conditions and nutrient cycling;
- Creating smaller, more dispersed patches and concentrating harvest at lower elevations in mountainous regions and on more nutrient rich soils, resulting in habitat fragmentation;
- Causing soil disturbance and compaction by heavy equipment, which may result in increased water runoff and slower tree growth at the site; or
- Giving a competitive advantage to commercially-valuable tree species and reducing the structural complexity of the forest through the application of harvest, planting, thinning, and herbicide treatments.
- Forest practices often have a smaller footprint on the landscape than widespread fire, insect, or wind damage.

Forest management may (or may not) be compatible with creating or maintaining habitats capable of supporting hares and lynx. Where the objective is to provide snowshoe hare habitat by creating additional early-successional forest conditions, management considerations include selecting areas that are capable of, but not currently providing, dense horizontal cover, designing the appropriate size and shape of treatment units, retaining coarse woody debris, and maintaining high stem densities in regenerated forests (Koehler and Brittell 1990, Homyack *et al.* 2004, Bull *et al.* 2005, Fuller and Harrison 2005, Ivan 2011a).

North America is the world's leading producer and consumer of wood products. Therefore, worldwide trends in forest products markets greatly affect forest management outcomes and thus, the amount and quality of lynx habitat in the DPS. Forest management decisions (e.g., to focus on hardwood or softwood production) can change dramatically in response to unpredictable and changing forest products markets. Globalization of manufacturing and expanded use of electronic media have reduced demand in pulp and paper since the late 1990s, and the collapse of housing construction since 2006 have contributed to declines in U. S. wood product output. Within the northern region of the U. S. (Maine to North Dakota) there has been a considerable decline in terms of employment, mill numbers, wood consumption and forest harvests since 2000 (Woodall *et al.* 2011). As a large amount of this region's forest industry is print paper manufacturing and composite panel production, the rise of electronic media and decline of home construction has precipitated a decade of decline, which only deepened since the recession of 2007-2009. The West, prior to the recession, was a major softwood lumber producing region, and was particularly hard hit by the recession and housing

collapse. Employment dropped by 30 percent or nearly 80,000 workers and annual value of output fell by more than 25 percent (Keegan *et al.* 2011). Under depressed markets, landowners may reduce harvests, which may be to the detriment of lynx in some parts of the DPS (e.g., Maine and Minnesota), and to the benefit of lynx in others (the West).

Markets for softwood products are particularly volatile and depend on demand for paper and housing. Thus, softwood management is affected by economic factors that are difficult to predict. In recent years, the forest products industry throughout the U. S. experienced a downturn in output levels not seen in decades, and employment losses in the hundreds of thousands (Woodall *et al.* 2011, p. 595). Despite depressed markets, one area of increasing interest is bioenergy production. Rising energy costs and growing concerns over global climate change have increased interest in bioenergy production, and the U. S. Energy Independence and Security Act (2007) mandates a five-fold increase in biofuel production (Benjamin *et al.* 2009, p. 125). The wood pellet sector is expected to grow, although woody biomass is typically the lowest value wood commodity sold from the forest. Thus, it is questionable whether wood energy revenues would be enough to sustain forest investments and forest management into the future (Woodall *et al.* 2011, p. 601).

Whereas management of state and federal forest lands have been relatively stable in recent decades, management and ownership of private forest land ownership has been extremely unstable. This has resulted in major shifts in forest management strategies, outcomes, and products. For example, in the last two decades in Maine, where nearly all the lynx critical habitat is on private land, about 23.8 million acres (80 percent) of industrial land ownerships in the "northern forest" (Adirondacks to northern Maine) were sold to a host of financial groups (Hagan *et al.* 2005). These groups have short-term investment goals and different management objectives and have dramatically changed harvest practices. Whereas the previous large industrial landowners focused on the forest land base as a supply for their manufacturing facilities, the new TIMOs and REITs focus on maximizing return on their investment (Jin and Sader 2006, p. 178). Initially, the effects of ownership changes were uncertain (McWilliams *et al.* 2005), but an evaluation of harvesting in the last decade indicates these landowners increased harvest rates, shortened rotation rates, and shifted to managing and harvesting hardwood tree species (Jin and Sader 2006, p. 183-185). On one hand, these trends in Maine private lands management make lynx management commitments more difficult because short-term landowners are not interested in long-term commitments. On the other hand, some easement owners may have an incentive to manage for lynx to meet forest certification requirements.

The extensive sale of private forestlands initiated the growth of conservation easements in this region (deGooyer and Capen 2004, Lilieholm *et al.* 2010). Conservation land as a percentage of Maine's state area increased from less than 5 percent in 1987 to approximately 19 percent by 2012 (Beck *et al.* 2012, p. 15). Conservation easements restrict development but usually do not affect forest management; neither do they typically require management for lynx and other rare species. Some private forestlands were sold to state and federal agencies and conservation interests. For example, in recent years The Nature Conservancy purchased 310,000 acres of

private forestland in Montana and 185,000 acres of private forestland in northern Maine. Lands in conservation ownership have a high probability of being managed to benefit hares and lynx.

Finally, future trends in forest management will be affected by climate change (Irland *et al.* 2003, entire). Many models have been developed to project how U.S. timber production and markets may adapt to climate change (e.g. Burton *et al.* 1998, Joyce *et al.* 1995, Perez-Garcia *et al.* 1997, Sohngen and Mendelsohn 1998). Economic models predict that under climate change, total U.S. timber inventories will increase, timber harvest will increase, and product prices will decrease relative to an assumed stable climate. Some models predict that consumers will gain from climate change while landowners in some regions will lose. The forest industry will adapt to climate change in many ways including using alternate tree species in manufacturing, shifts to geographic regions of the country with economic advantages in timber growth, and increasing forest plantations with new species that are favorably adapted to the new climate and markets. Many strategies have been evaluated to increase the quantity of carbon stored in North American forests (Irland *et al.* 2003) including discontinuing or greatly reducing harvest in some forests to build carbon reserves, increased recycling to reduce use of forest products, converting agricultural lands to forests, and substituting wood products for more energy-intensive products. Increased atmospheric carbon will increase forest growth slightly, except for softwood (Irland *et al.* 2001, p. 757-758). Sawtimber production, which sequesters more carbon, is expected to increase (Irland *et al.* 2001, p. 758). Expanding landscapes with older growth conifer forest to sequester carbon could benefit lynx in the West and be to the detriment of lynx in the East.

Climate change will affect forest-related recreation. Warmer lowland temperatures will attract more people to relatively cooler mountainous and northern forests (Irland *et al.* 2001, p. 759). The ski industry is currently in decline, and climate-induced changes in snowfall will further stress this industry, except for higher elevation western resorts where snowfall is more dependable and where artificial snow is less expensive to make (Irland *et al.* 2001). These climate-induced trends in recreation are anticipated to bring more people into the lynx DPS, which could bring additional social pressures concerning decisions related to forest management (e.g. clearcutting) (Swanson and Loomis 1996). At this time, there are many uncertainties concerning the socioeconomic implications of climate change and adaptation in the northern forests supporting the lynx DPS.

Past and future forest management affects many of the requirements necessary for the continued existence of lynx in the DPS. Forest management is expected to be the predominant land use throughout the DPS into the foreseeable future, and major climate-induced changes in forest industry are anticipated (Irland *et al.* 2001, entire). Beneficial effects of forest management include 1) creating lynx habitat, 2) maintaining an undeveloped landscape conducive to lynx, and 3) long term management planning for lynx (especially on federal lands). Adverse effects to lynx, hares, and their habitat that are occurring or can be reasonably be anticipated include 1) reduced quality of hare habitat in some parts of the DPS, 2) loss and fragmentation of lynx and hare habitat in the U. S., and 3) changes in the frequency and pattern of disturbance events. Synergetic effects between forest management and other stressors (e.g.,

climate change, trapping, development) may intensify their effects (Carroll 2007). Habitat loss and fragmentation are believed to currently be the most important stressors for lynx in the DPS (Fig. X), but it is possible that other pathways for forest management are, or may become, equally important. Hares and lynx will continue to be affected (both positively and negatively) by forest management into the foreseeable future. Forest management stressors primarily affect lynx by lowering landscape hare densities, which in turn reduce lynx reproduction and lower

Reduced Quality of Hare Habitat - Throughout the lynx DPS, some vegetation management practices, especially thinning in young, dense regeneration, reducing overstory canopy in mature multi-story spruce-fir forests (in the West), and partial harvesting (in northern Maine) reduce the quality of boreal forest habitats for snowshoe hares and lynx. This could cause lynx to increase their home ranges, reduce productivity, or in extreme cases to abandon their home range or cause mortality.

Thinning of young, dense sapling stage conifers (precommercial thinning) is a forest management practice used widely throughout the DPS to increase the growth and value of selected trees and to reduce the time to maturity of a stand of trees. Precommercial thinning removes competing trees of the same species or shrubs and trees of other species (Daniel *et al.* 1979; Homyack *et al.* 2005, 2007). Reducing the density of sapling-sized conifers in young regenerating forests to increase the growth of certain selected trees promotes more homogeneous patches and reduces the amount and density of horizontal cover, which is needed to sustain snowshoe hares (Sullivan and Sullivan 1988, Hodges 2000b, Griffin and Mills 2004, Ausband and Baty 2005, Griffin and Mills 2007, Homyack *et al.* 2007, Ellsworth 2009). Hares reach highest densities in stands with stem densities ranging from 4,600–33,210 stems/ha (1,862–13,445 stems/ac)(Wolff 1980, Parker 1984, Litvaitis *et al.* 1985, Monthey 1986, Parker 1986, Koehler 1990a, Griffin 2004, Fuller and Harrison 2005, Robinson 2006, Scott 2009), whereas thinned stands have densities of 2990 (6-foot spacing) to 1,682 (8-foot spacing) stems/ha (Pitt and Lanteigne 2008, p. 593). Precommercial thinning has been shown to reduce hare numbers by as much as 2- and 3-fold (Griffin and Mills 2004, 2007; Homyack *et al.* 2007) because of reduced cover and decreased availability of browse. Griffin and Mills (2007) reported that, if their results were representative, the practice of precommercial thinning could significantly reduce snowshoe hares across the range of lynx.

There are anecdotal examples of precommercially thinned stands that subsequently "filled in" with understory trees. Some have suggested this could be a technique to extend the time that understory trees and low limbs provide the dense horizontal cover that constitutes snowshoe hare habitat. The duration between time of thinning and regrowth to a height providing winter snowshoe hare habitat would likely vary by tree species, each having different regenerative capacities that could be influenced by a variety of local factors (e.g., topographic relief, moisture, and mineral and organic content of the soil; Baumgartner *et al.* 1984, Koch 1996). Bull *et al.* (2005) reported that the slash and coarse woody debris remaining after precommercial thinning provided both forage and cover for snowshoe hares up to a year following treatment. However, Homyack *et al.* (2007) found that snowshoe hare densities were reduced following precommercial thinning for 1–11 years post-thinning. They further suggested that after

precommercial thinning, the stands did not regain the structural complexity in the understory that would be needed to support pre-treatment snowshoe hare densities. At this time, no other data are available to quantify the re-establishment of snowshoe hare habitat and over what time period, or the response by snowshoe hares, as compared with sites that were not precommercially thinned, so this remains an unproven management technique. As an alternative to standard precommercial thinning (i.e., complete thinning resulting in a homogeneous patch), Griffin and Mills (2007) suggested retaining at least 20 percent of the patch in untreated clumps of about ¼ ha (½ ac), which would maintain hare habitat in the short term. However, Lewis *et al.* (2011) found that landscapes with patches of high-quality habitat surrounded by similar vegetation supported more hares than did more fragmented landscapes composed of high-quality patches in a matrix of poorer-quality habitat. Further long-term studies of modified thinning methods are needed.

Because of documented adverse effects of precommercial thinning to snowshoe hares and lynx, in 2007 and 2008 the USFS amended Forest Plans to incorporate management that would conserve lynx, including direction that prohibited precommercial thinning in most lynx foraging habitat (USFS 2007, pp. 8, 11-14, 36; USFS 2008, pp. 6-9, 23-26) . However, precommercial thinning is not regulated on private forest lands throughout the remainder of the DPS.

Uneven-aged management (single tree, partial harvest, and small group selection) practices can be employed in stands where there is a poorly developed understory, but have the potential to produce dense horizontal cover for snowshoe hares. Removal of select large trees can create openings in the canopy that mimic gap dynamics and help to maintain and encourage multistory attributes within the stand. However, if removal of large trees opens the canopy to the extent that the patch functions as an opening, this may discourage use by lynx (Koehler 1990a, von Kienast 2003, Maletzke 2004, Squires *et al.* 2010). Removal of larger trees from mature multi-story forest stands to reduce competition and increase tree growth or resistance to forest insects may reduce the horizontal cover (e.g., boughs on snow), thus degrading the quality of winter habitat for lynx (Robinson 2006, Koehler *et al.* 2008, Squires *et al.* 2010). Similarly, removing understory trees from mature multi-story forest stands reduces the dense horizontal cover selected by snowshoe hares, and thus reduces winter habitat.

Partial harvesting broadly describes many methods of removing a portion of the overstory trees from a forest stand. Partial harvesting includes selective cuts, shelterwood cuts, and uneven-aged management. Partial harvest may be “light” (e.g., <10 percent of trees removed) to “heavy” (e.g., 90 percent of trees removed). Since passage of the Maine Forest Practices Act in 1989, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine (Sader *et al.* 2003, entire). In recent years, about 425,000 acres of Maine forest are harvested annually and 96 percent of this land is partially harvested (Maine Forest Service 2016? Check). After 17 years of extensive partial harvests, much of the northern Maine landscape has been influenced by this form of forestry, and will continue to be into the future. The popularity of this form of harvesting extends beyond Maine. From the mid-1980s to mid-1990s, partial harvesting comprised 62 percent of the harvest in the U. S., and clearcuts comprised the other 38 percent. Partially harvested stands result in a wide range of

residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006). On average, partially harvested stands supported about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006). Shelterwood cuts, a form of even-aged management, are the exception and have maintained densities similar to regenerating clearcut stands (D. Harrison, U. Maine, unpubl. data). Current hare densities in partially harvested stands in Maine average about 0.4 hares/ha (Simons 2009, p. XXX, check), which is below the landscape hare densities (0.5 hares/ha (Ruggiero *et al.* 2000b, Simons-Legaard *et al.* 2013) needed to support lynx.

In the Great Lakes Geographic Unit, prescribed burning is used in lynx habitat primarily as a tool to reduce fuels (including from blow-down) and mimic a more natural fire regime in pine forest types (Plate 4.4). In these instances there is a short-term (10–30 years) impact on snowshoe hare habitat. In the western U.S., prescribed fire for ecosystem restoration is most applicable to the dry ponderosa pine and Douglas-fir forests that are not lynx habitat. Because spruce-fir forests are generally composed of thinner-barked trees that are easily killed even with light fire, this technique is not used frequently in most lynx habitat.

Biomass removal for energy production targets the removal of dead trees, logging slash, and small-diameter trees and shrubs. Biomass removal is similar to fuels treatments in reducing cover and habitat for snowshoe hares.

Fuels treatments commonly are designed to remove understory biomass and reduce stem density in forests that are outside their historical range of variability, and to clear fuels adjacent to human developments for safety or to protect investments (Plate 4.3). These types of projects are becoming more common. In the western U.S., projects designed to restore forests to a condition more representative of the historical range of variability are generally targeted to drier, lower-elevation forests affected by fire suppression (Hessburg *et al.* 2005), which are not lynx habitat. Lynx habitats in higher-elevation spruce-fir forests have been less affected by past fire suppression and are mostly within the historical range of variability (Agee 2000). Fuels treatments may be needed to protect human communities and capital improvements by reducing the intensity and rate of spread of a fire, affording control actions with a higher probability of success and providing safer conditions for firefighters. By removing or reducing the understory and ladder fuels to meet those objectives, dense horizontal cover important to snowshoe hares is reduced and habitat value is diminished for hares and lynx.

Loss, Degradation and Fragmentation of Boreal Forest Habitat - Forest management rarely results in conversion of lands to non-forest. In fact, forested landscapes have increased in some parts of the DPS (especially in the Northeast) because of farm abandonment and recolonization by second-growth forest. However, some forms of forest management such as selective harvesting and fire suppression can intentionally (or not) alter tree species composition away from boreal forest types that support snowshoe hare and lynx. Similarly, lack of forest management can alter tree species composition (Trani *et al.* 2001, pp. 415-417). Other stressors, such as insects and climate change, can work in synergy with forest management to reduce boreal forest. For example, in northern New England clearcutting leads to drying of the

forest floor and consequent heavy mortality in spruce and fir regeneration and increased light levels that increase hardwood competition (White and Cogbill in Eagar and Adams 2012, p. 32).

Plantations can convert native forest communities into monocultures of a native or exotic tree species that may lack hardwood browse for snowshoe hare. Cutting rotation can be reduced by half through mechanical site preparation, planting, and suppression of hardwood competition. Conifer stem densities in plantations range from 800-5,000 stems/ha and may support relatively low populations of snowshoe hares because of the initial wide spacing of trees (Bellefeuille *et al.* 2001, p. 44). Hare densities may increase after trees in a plantation reach the sapling stage and branches intermingle at the ground level creating horizontal cover if the lateral branches are not pruned (Parker 1984, p. 163, Parker 1986 p. 160, Roy *et al.* 2010, p. 285). However, the period of time that spruce plantations may support high hare densities in Maine and eastern Canada may be relatively short (10 to 17 years post-harvest) compared to regenerating softwood clearcuts (15-35 years post-harvest)(Simons-Legaard *et al.* 2013, p. 569).

Under certain forest stand conditions, herbicide treatment may have long-term effects on stand composition and structure (MacLean and Morgan 1983, Daggett 2003), thus reducing food, cover, and habitat for hares (Borrecco 1976, Bellefeuille *et al.* 2001, p. 43, Thompson *et al.* 2003 p. 462). Understory deciduous stems were lacking in stands treated with herbicide (Homyack *et al.* 2004). Although herbicide treatments reportedly do not directly affect survival, fecundity, or other demographic parameters of snowshoe hares (Sullivan 1996), treatments have indirect effects on hares via changes in vegetative cover and browse (Homyack *et al.* 2005, p. 10). In Norway, hares use of plantations was reduced up to 10 years after herbicide application (Hjeljord *et al.* 1988).

Fragmentation - Lynx achieve highest densities in >100 km2 landscapes having a high percentage of large, contiguous patches of high quality hare habitat (Simons 2009, Simons-Legaard *et al.* 2013). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges, by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that land-scapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Forest management can fragment and isolate patches of high quality hare habitat (Simons-Legaard *et al.* 2016). In an intensively managed landscape, lynx habitat is described as a shifting mosaic of patches of habitat suitable to support the needs of resident lynx (FR 74(36)). Fragmentation of the naturally patchy pattern of lynx habitat in the contiguous U.S. can affect

lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation from forest management can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. For example, in Maine the proliferation of partial harvesting will actually increase the patches of high quality hare habitat by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6).

Changes in Frequency and Pattern of Disturbance Events - Prior to European settlement, the dominant natural disturbance processes that created early-successional stages within the range of the lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of the Northeast Geographic Unit, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S.

Today, forest management is the predominant form of disturbance in boreal forest types throughout the DPS, but in the West insect outbreak or wildfire are also critical agents of disturbance that influence and interact with forest management. Throughout the DPS, the frequency of harvesting accelerates in response to salvaging insect damaged stands. In some instances, forest management has greatly altered the disturbance regime. For example, the Acadian forest in Maine and eastern Canada was driven by gap dynamics (similar to some parts of the West today) and true stand-replacing disturbances were quite uncommon with recurrent intervals of thousands of years. After several centuries of forest management, stand age structures have become simplified, and commercial timber rotations are a fraction (15 to 40 percent) of the lifespan of boreal tree species (Seymour 2002). Whereas prevalent, these younger even-aged forest stands on the landscape may benefit hares and lynx in Maine, forestry has shifted the species composition of Maine's forest to species favored by frequent harvest disturbance, such as red-maple, paper birch, aspen, and balsam fir.

3.4 Wildland Fire Management

Wildfire is a natural and essential component of boreal and montane forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger *et al.* 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Wildfire creates and maintains lynx habitats by providing periodic vegetation disturbances that result in the spatial and temporal distribution of early-successional forest stands or patches within older stands featuring dense horizontal cover at ground and snow level. These stands/patches provide high-quality hare foraging habitat and typically support high densities of hares, which in turn provide high-quality lynx foraging habitat.

They are generated by (1) high-intensity, stand-replacing fires that result initially in removal of all or most vegetation, followed by regeneration of dense horizontal cover, or (2) low- or moderate-intensity fires that stimulate understory development in older stands without killing all the overstory, resulting in patches of dense horizontal cover within multi-storied stands (Agee 2000, p. 53; Ruediger *et al.* 2000, p. 7-6). These habitats become most favorable for hares and lynx when regenerating conifers grow tall enough to protrude above the snow, providing cover and food for hares throughout the winter (ILBT 2013, pp. 10-12). They remain important as winter foraging habitat, which may be the most limiting habitat for lynx (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 17, 27), until they reach the stem-exclusion structural stage and self-pruning results in the loss of dense horizontal cover above the snow, or until another disturbance resets them to the stand-initiation structural stage (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 1-3; ILBT 2013, p. 27). The length of time to achieve favorable hare and lynx habitat after fire (or other vegetation disturbance) and the duration for which those conditions persist vary across the lynx range depending on soil and vegetation potential, temperature and precipitation patterns, topography, fire intensity, and perhaps other local conditions (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 2-5; ILBT 2013, pp. 27-29, 75). Generally, regenerating forests in the DPS range may begin providing winter hare habitat within 10-20 years after fire or other disturbance, with favorable conditions persisting for 20-30 years after that (Koehler and Aubry 1994, pp. 86-87; Agee 2000, pp. 67-71; Fuller *et al.* 2007, p. 1985; McCann and Moen 2011, p. 515; Vashon *et al.* 2012, p. 15; ILBT 2013, pp. 28-29), although it may take longer, perhaps 35-40 years, for lynx habitat to recover in some parts of the range (e.g., Maletzke *in* Lynx SSA 2016, p. 21).

Fire frequency, size, intensity, and return intervals also vary across the range of the lynx and depend on localized vegetation communities, climatic conditions, and topography (Agee 2000, pp. 47-56; Ruediger *et al.* 2000, p. 4-8; ILBT 2013, pp. 75-76). In lynx habitats, fire intensity is typically high and fire return intervals long but variable, with large areas affected by infrequent stand-replacing fires and, in mixed fire regimes, moderate- or low-intensity fires in the intervals between stand-replacing events (Agee 2000, pp. 49-54; Ruediger *et al.* 2000, pp. 4-8, 7-6). Within the DPS range, fire return intervals in the Great Lakes Region appear similar to those in the core of the lynx's range in the Canadian and Alaskan taiga (roughly 50-150 years), with longer return intervals in Western (150-300 years) and Northeastern (up to 500 years) U.S. forests (Agee 2000, pp. 52-53; ILBT 2013, pp. 75-76). Despite these long intervals, fire is the dominant natural disturbance mechanism in lynx habitats in the DPS range except in the Northeast, where insects and wind are more important (Agee 2000, p. 53).

Current federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI *et al.* 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Calkin *et al.* 2015, pp. 1-3) which, combined with other land-use practices, dramatically altered fire regimes in some places and created conditions prone to larger and more severe fires (USDI *et al.* 2001, p. 1-2). Because of (1) fire's important role in creating and maintaining high-quality early-successional hare habitat in most lynx habitats in the contiguous

U.S., (2) the potential for fire suppression to alter this dynamic to the detriment of hares and lynx, and (3) the limited ability of land managers (at that time) to use fire to benefit hares and lynx, wildland fire management was identified as a "Lynx Risk Factor Affecting Lynx Productivity" (Ruediger *et al.* 2000, pp. 2-5, 5-2). To address these concerns, the authors developed objectives, standards, and guidelines for federal land managers to restore fire's role in maintaining lynx habitats, attempt to mimic historic natural fire regimes, and integrate lynx habitat objectives into fire management plans (Ruediger *et al.* 2000, pp. 7-6 - 7-8). They also directed federal land managers to evaluate whether fire suppression or other management practices had altered fire regimes and ecosystem function in potential lynx habitats and, where so, to use fire (naturally ignited fires or prescribed burns) as a tool to restore and maintain lynx habitat by creating or regenerating snowshoe hare habitat (Ruediger *et al.* 2000, p. 7-7).

In its 2000 listing rule and 2003 remanded determination, the Service recognized the potential for fire suppression to adversely affect lynx and hare habitats at local and regional scales, particularly in the Great Lakes Region, where fire suppression policies across land ownerships likely prevented fire from assuming its natural role in creating a landscape mosaic of vegetation communities and age classes (65 FR 16076; 68 FR 40095). In the Northeast, the Service concluded that the very long fire return intervals and maritime influence in lynx forest types indicated that fire did not historically play a significant role in creating or maintaining lynx and hare habitats and, thus, fire suppression was unlikely to have affected lynx habitat (68 FR 40094). In the West, the Service concluded that the effects of fire suppression were likely lower in lynx forest types because of their typically long fire return intervals compared to lower and drier forest types (65 FR 16074; 68 FR 40093-94). Overall, the Service concluded that fire suppression did not represent a threat to lynx in the Northeast and was a low-magnitude threat in Great Lakes, S. Rockies, and N. Rockies/Cascades (65 FR 16075-16076; 68 FR 40093-40098).

In response to the guidance provided in the LCAS, the USFS, when developing the NRLMD and the SRLA to amend forest plans to address lynx conservation (see 3.1.1, above), evaluated whether fire suppression had adversely affected potential lynx habitats on national forests in the Northern and Southern Rockies. The USFS concluded that many forests in potential lynx habitat are in Condition Class 1, which means they have not missed a fire cycle because large, stand-replacing fire only occurs every 100 to 200 years; the long fire return interval has not been affected to any large degree by more recent fire suppression as is the case in drier forests with short fire return intervals; and they are close to historic conditions (USFS 2007, pp. 18, 20; USFS 2008, p. 11). In addition to the national forests covered by the NRLMD and SRLA (all national forests in the Northwestern Montana/Northeastern Idaho, GYA, and Western Colorado SSA units), the Superior National Forest, which accounts for 45 percent of the Northeastern Minnesota unit, revised its forest plan to adopt lynx conservation measures consistent with the LCAS (USFS 2004, Appendix E). The Okanogan-Wenatchee National Forest in the North-central Washington unit is currently revising its management plan and continues to manage for lynx conservation in accordance with the LCAS, including direction to restore fire to its natural ecological role and to use it as a tool to restore and maintain hare and lynx habitats.

As described above in section 3.1.1, current federal management on most USFS and BLM lands, in accordance with formally revised or amended management plans, includes limits on the proportion of lynx habitat within LAUs that can be in an unsuitable condition at any given time, including such conditions, usually temporary, created by wildfire. Although some exemptions and exceptions to these limits are permitted for activities to reduce fire risks to communities and infrastructure in the wildland-urban interface (WUI) or to achieve other resource benefits, even these potential impacts are limited on the larger landscape scale (USFWS 2007, p. 7). These conservation measures and the direction to use fire management as a tool to restore hare and lynx habitats and return to natural temporal and spatial patterns of fire disturbance, which were not in place when the DPS was listed, likely further reduce what was even then considered the low potential threat to lynx of past fire suppression activities. Based on the information above, we conclude that fire suppression and other fire management activities have not substantially impacted lynx and hare habitats in the DPS range and are unlikely to do so in the future.

However, warming temperatures attributed to climate change are reducing snowpack, causing earlier snowmelt and longer and more extensive droughts, resulting in longer wildfire seasons and increased fire frequency, size, and intensity in boreal forests of the north and in boreal and montane forests in some parts of the DPS range (Weber and Flannigan 1997, entire; Stocks *et al.* 1998, entire; Gillett *et al.* 2004, entire; Kasischke and Turetsky 2006, entire; Soja *et al.* 2007, entire; Pierce *et al.* 2008, entire; Flannigan *et al.* 2009, entire; Krawchuk *et al.* 2009, entire; Le Goff *et al.* 2009, entire; Bergeron *et al.* 2010, entire; Salathe *et al.* 2010, entire; Abatzoglou 2011, entire; McKelvey *et al.* 2011, entire; Abatzoglou and Kolden 2013, entire; Pederson *et al.* 2013, p. 1815; Price *et al.* 2013, pp. 342-343, 352-354; Barbero *et al.* 2014, entire; Trenberth *et al.* 2014, entire; Barbero *et al.* 2015, entire; Jolly *et al.* 2015, entire; Lute *et al.* 2015, entire; USEPA 2015, entire; Lienard *et al.* 2016, entire; Littell *et al.* 2016, entire; Westerling 2016, entire; see also section 3.2 above). Increases in fire frequency and size have the potential to adversely affect lynx and hare habitats in the DPS range by rapidly converting large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats (ILBT 2013, p. 70). Although this would likely be a temporary impact, with burned areas subsequently regenerating into higher-quality habitat, it would likely reduce landscape-level hare densities and, therefore, lynx numbers, potentially compromising an area's ability to support a resident lynx population until burned habitats recover.

Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already naturally marginal in many parts of the DPS range, it is possible that very large wildfires or many over a short time period could, perhaps in concert with other influencing factors, tip an area from just barely capable of supporting a resident lynx population to no longer capable of doing so, resulting in extirpation. For example, multiple large fires in north-central Washington over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). It may take 35-40 years for these areas to

recover as lynx and hare habitat (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and other habitat impacts could further diminish habitat availability and the lynx population's probability of persistence (Lewis 2016, pp. 5-6; Lynx SSA Team 2016, p. 44; also see section 2.3.2.2, above, and sections 4.1.4 and 5.1.4, below). The loss of habitat resulting from these fires and its potential demographic impacts on the State's only resident lynx population contributed substantially to the Washington Department of Fish and Wildlife's recent recommendation to uplist lynx from threatened to endangered under its State Endangered Species Program (Lewis 2016, entire).

Wildfire frequency, size, and intensity have also increased in the Northwestern Montana/ Northeastern Idaho geographic unit, where about 4,172 km^2 (1,611 mi^2; over 15 percent of the unit) have burned in western Montana from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20). Large fires have also impacted lynx habitat in the Western Colorado geographic unit, where fire size, frequency, and intensity are expected to increase with climate change (Ivan *in* Lynx SSA Team 2016, p. 23). As mentioned in section 2.3.2.2, large areas of the GYA unit were burned by the extensive wildfires of 1988. The extent to which those fires may have diminished lynx and hare habitats and contributed to the recent absence of resident lynx is uncertain, as is the potential for those burned areas to support high hare densities and resident lynx in the future. However, some burned areas may soon develop the dense horizontal conifer structure favorable for hares and, therefore, for lynx foraging habitat, perhaps increasing the likelihood that they may support resident lynx in the near future.

Although fire suppression was in the past thought to be a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

3.5 Habitat Loss and Fragmentation

Boreal forest habitats in the DPS are patchy and marginal for both snowshoe hares and Canada lynx. In this region, boreal forest transitions to various types of northern hardwood forest. The transitional nature of the boreal forest at its southern extent is believed (along with competition from other hare predators) to limit the numbers of both hares and lynx, preventing either from regularly achieving densities comparable to those regularly achieved in the classic boreal forests at the centers of their ranges in north-central Canada and Alaska (79 FR 54790). Lynx must contend with aspects of their habitat at the southern extent of the boreal forest for which they are not as well-adapted.

Fragmentation has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991). "Patchiness" is sometimes used to refer to natural processes (Buskirk *et al.* 2000a, p. 85), whereas and "fragmentation" to anthropogenic disruption of natural patterns. Habitat loss is conversion of forest to another land use or vegetative cover.

Forest loss and fragmentation are relatively low in the DPS compared to other forested regions in the United States (Heilman *et al.* 2002, p. 416). Since 2000 in the western United States, land uses associated with residential development, roads, and highway traffic have resulted in a 4.5% loss in area (20,000 km^2) of forest, and continued expansion of residential development will likely reduce forested patches by another 1.2% by 2030 (Theobold *et al.* 2011 (entire). Fragmentation in the forested western landscape resulted in a decline of weighted mean patch size from roughly 35,000 to 3,200 km^2 from natural to current conditions, but models predict relatively small declines in the size of forested patches over the next 30 years (Theobold *et al.* 2011 p. 2451). In the eastern United States, nearly half or more of the natural forest was cleared in the past three centuries but as agriculture and settlement relocated westward, eastern forest cover rebounded (Williams 1989, Smith *et al.* 2005). Maine's forest area has increased 0.79 percent since 1982 (Maine Forest Service, Department of Conservation 2010, p. 25). Similarly, a large portion of Minnesota forests were cleared in the last century, but forest cover has rebounded. The forest area in northern Minnesota has decreased 4 percent since 1977 (Miles *et al.* 2007, p. 22). Preliminary findings from the 2002 U.S. timber assessment (Haynes 2003) indicate that approximately 15 to 20 million acres of U.S. forest land could be converted to urban and developed uses over the next 50 years. Such land use conversions could result from residential development in forested landscapes, as the U.S. population is estimated to grow by another 126 million people.

Habitat fragmentation (both natural and anthropomorphic) directly affects snowshoe hares and lynx by various mechanisms; reducing hare survival and landscape hare densities, increasing lynx home ranges, reducing lynx reproduction and survival, and affecting lynx movements throughout the landscape. Habitat fragmentation also influences mesocarnivore communities that coexist with lynx and the level of competition for space and food resources. Fragmentation from anthropomorphic sources results in habitat alteration, direct habitat loss, vehicle collisions and behavioral disturbance from roads, and changes in landscape features such as edges.

Landscapes in which hare habitat is more contiguous, or where good patches of hare habitat are surrounded by other patches of similar habitat quality, support more hares than landscapes that are more fragmented or include matrix habitats that are poorer quality (Lewis *et al.* 2011, p. 565). Thus, southern transitional boreal forests generally have lower landscape snowshoe hare densities than boreal forests further north (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84). This may have as much to do with the quality of the matrix habitat between high quality patches as the hare densities that occur in the high quality patches themselves (Lewis *et al.* 2011). Low-quality matrix habitat, typical throughout much of the DPS, could decrease survival for hares, because predators might have higher hunting success or be more numerous in the matrix habitats (Griffin and Mills 2009). In contrast, a high-quality matrix, typical of Canadian boreal forest, can provide alternative or supplemental resources (Dunning *et al.* 1992; Norton *et al.* 2000), thus supporting higher densities of hares in the prime habitats.

The patchy distribution of hares and differences between landscape hare densities in the contiguous United States require lynx in most areas to incorporate more land area into their home ranges than lynx do in the north to acquire adequate food (Mowat *et al.* 2000, pp. 265, 277–278). At some point, landscape hare densities become too low, making some areas incapable of supporting lynx. Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range.

Throughout the northern part of their range, snowshoe hares are found in continuous areas of boreal forest; conversely, southern populations occur primarily in insular patches of suitable habitat set amidst less-preferred areas (Wolff 1980; Keith *et al.* 1993). This disparity has led a number of biologists to speculate that habitat fragmentation may be ultimately responsible for the non-cycling nature of snowshoe hare populations in the northern U. S. and southern Canada (Dolbeer and Clark 1975; Buehler and Keith 1982; Keith *et al.* 1993, Strohm and Tyson 2009). Wolff (1980, 1981) described the mechanism by which a fragmented habitat might dampen or eliminate cyclic population fluctuations.

Forest fragmentation may exacerbate competition between lynx and other predators (Buskirk *et al.* 2000a, entire). Fragmentation and competition are strongly linked because vegetation mosaics in landscapes provide high quality environments for generalist species such as the bobcat, red fox, and coyote (Goodrich and Buskirk 1995, Buskirk *et al.* 2000a, p. 84). Under such conditions, generalist predators tend to dominate the predator guild in fragmented landscapes (Oehler and Litvaitis 1996). Hares fluctuate less dramatically in the southern part of the range of lynx, thus there is more competition for a limited resource and exploitation competition inflicted by generalists (e.g., coyotes) and other predators (Buskirk *et al.* 2000a, p. 95).

Snowshoe hares in the south are concentrated in isolated patches of suitable habitat and subject to predation by a suite of generalist predators (e.g., Litvaitis *et al.* 1985; Sievert and Keith 1985; Keith *et al.* 1993; Cox *et al.* 1997). Keith *et al.* (1993) found that extremely high predation rate on hare living in high quality hare habitats, rather than predation on naturally dispersing individuals, seemed to be driving the changes in distribution and abundance in a snowshoe hare population in Wisconsin. In this study, predation pressure on populations occupying small (<7 ha) patches of preferred habitat was so severe that 3 of the 5 populations under investigation went extinct in the course of the 3-year study. Fragmentation of landscapes exacerbate the effect of predation by allowing carnivores to concentrate their hunting efforts on small patches of habitat used by their preferred prey instead of preying disproportionately on dispersing individuals (Wirsing *et al.* 2003, p. 170). In predator-rich landscapes characteristic of the DPS, this can result in intense predation and competition for a limited prey resource.

Lynx seem to be flexible in their response to habitat fragmentation whereas closely related species, such as bobcats and Iberian lynx, are sensitive to habitat fragmentation (Ferreras 2001, Crooks 2002). In a southern Ontario landscape Hornseth *et al.* 2014 (pp. 8-9) demonstrated that lynx exhibited a wide range of responses to habitat alteration. In general, lynx

responded most positively to areas having greater than 50 percent suitable habitat and generally avoided areas having less than 30 percent suitable habitat. However, lynx showed no sensitivity to the degree of forest fragmentation in areas of high or low suitable habitat.

All of these factors likely lead to lower reproductive output and more tenuous conservation status for lynx in many parts of the DPS relative to those in Canada and Alaska (Buskirk *et al.* 2000a, p. 95). Thus, factors that further fragment boreal forests in the DPS (e.g., climate change, forest management, roads and development) further reduce the probability of persistence of lynx.

The snow environment in the DPS is also patchy and marginal in both space and time for snowshoe hares and Canada lynx. Snow depth (Hoving *et al.* 2005, Peers *et al.* 2013, entire) and duration (Gonzales *et al.* 2007) give lynx a competitive advantage over generalist predators in the conterminous United States. Too little snow or crusting conditions favor competitors and predators like bobcat, fisher, and coyotes. High elevations may provide snow conditions that favor lynx, whereas low elevations favor conditions for competitors. Lynx may have competitive advantage at higher elevations in the DPS in the winter, but not in summer months when competitors may have free access to all habitats. In contrast, extensive deep, fluffy snow conditions favor lynx in broad areas of north-central Canada and Alaska.

Landscape features further fragment hare and lynx habitat. In lynx units in the western contiguous U.S., potentially suitable boreal forests and appropriate snow conditions occur in relatively narrow elevational bands in the Cascade and Northern and Southern Rocky mountains. Thus, appropriate habitats for lynx are naturally fragmented by topography and vegetation gradients. These “islands” of habitat can be extensive (e.g., the Okanagan in Washington or most of northwestern Montana) or smaller and relatively isolated (e.g., the Garnet Range in western Montana) depending on topography and precipitation patterns. Some of these areas of boreal forest are separated by unsuitable habitats in the low valleys (e.g., sage flats, urban corridors, agricultural lands) or by snow regimes (e.g. snow shadows) that may restrict lynx dispersal between habitat patches. In some western parts of the DPS range, lynx habitat in is also fragmented by rugged, high elevation terrain (Carroll *et al.* 2001, p. 976). In other areas of the DPS where there is little topography, including Minnesota and Maine, matrix forest facilitates lynx movements between suitable habitats. Large rivers are unlikely to fragment habitat as lynx readily swim across large bodies of water (Feierabend and Kielland 2014, entire) or cross them on ice in the winter (Koen *et al.* 2015).

Snow is an important component of lynx habitat (79 FR 54809). Snowfall can be patchily-distributed, variable and unpredictable from year to year, and affected by local topography, water bodies, and climate gradients. Snow conditions that provide lynx a competitive advantage over other terrestrial hare predators are most consistent in the high-elevation regions of the western U.S., although snow alone does not constitute lynx habitat (i.e., many places receive sufficient snow but lack other features lynx need, typically adequate hare densities). Snow conditions are less consistent in the East. For example, lake-effect snow from Lake Superior can increase snow depth and duration in the Arrowhead region of Minnesota in some years, but

not others. The Gulf of Maine has the reverse effect, and its warming influence reduces snow depth and duration inland. Distribution models by Hoving (2001, p. 74) indicate that eastern Maine has extensive areas of boreal forest but does not achieve snowfall thresholds that gave lynx an advantage over bobcats and other competitors.

Lynx populations are clearly most viable in areas having extensive, unfragmented boreal forest habitats with large patches of high-quality foraging habitat and persistent deep, fluffy snow. Both lynx and hares are influenced by the spatial arrangement of preferred habitat. In Ontario, lynx preferred habitats with a high degree of connectivity (Walpole *et al.* 2012, p. 769). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Several studies (Koehler 1990a, Mowat *et al.* 2000, von Kienast 2003, Maletzke 2004, Squires and Ruggiero 2007, Squires *et al.* 2010) have reported that lynx avoid large openings, especially during winter. Mowat *et al.* (2000) suggested that relatively few snowshoe hares use large openings, and consequently lynx spend little time hunting in these areas. Koehler (1990a) speculated that vegetation management prescriptions that result in distance to cover >100 m (328 ft) may change lynx movement and use patterns until such time as sufficient reestablishment of forest vegetation occurs. Opening size can also influence seedling regeneration and stocking densities (Kreyling *et al.* 2008).

Similarly, individual lynx have the smallest home ranges and greatest survival and productivity in landscapes that have extensive, large patches of habitat in combination with deep, fluffy snow. Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that landscapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Anthropogenic Sources of Fragmentation - Human activities can exacerbate the natural habitat fragmentation that is typical throughout much of the DPS range. Anthropogenic activities such as forest management, development, and highways alter natural landscape patterns. They cumulatively can reduce the total area of habitat, diminish the quality of habitat, increase the isolation of habitat patches, and impair the ability of lynx and other wildlife to effectively move between patches of habitat. Anthropogenic fragmentation may be permanent, for example by converting forest habitat to residential, industrial, or agricultural purposes, or temporary, for example by conducting forest management but allowing trees and shrubs to regrow. Habitat fragmentation (both natural and anthropogenic) increases the risk of extirpation of small lynx populations.

Human-caused fragmentation of the already naturally patchy pattern of lynx habitat in the contiguous U.S. can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. Maintaining a mosaic of large (>100 acres) patches of young to old stands in patterns that are representative of natural ecological processes and disturbance regimes would be conducive to long-term conservation of lynx (ILBT 2013, p. 77).

Roads, development, climate change, and forest management fragment snowshoe hare and lynx habitat in the DPS. We know little about how hare and lynx respond to these anthropomorphic changes to their habitat, which requires additional research (Murray *et al.* 2008, p. 1464; Squires *et al.* 2013, p. 194). In the next decades, southern lynx populations will incur further habitat loss and fragmentation and the effects of climate change. Changes in habitat, prey base, and competitor guild will further stress southern lynx populations and possibly populations in southern Canada. Ultimately, the extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in its current southern range (Murray *et al.* 2008, p. 1469).

Roads - Paved highways fragment lynx habitat. In the West, they typically follow natural features such as rivers, valleys, and mountain passes that may have high value for lynx in providing habitat or connectivity. They surround large blocks of lynx habitat in Minnesota and northern Maine. Various studies have documented lynx crossings of highways. A male lynx in western Wyoming was documented to have successfully crossed several 2-lane highways during exploratory movements (Squires and Oakleaf 2005). However, in Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx (Bayne *et al.* 2008). Apps *et al.* (2007) found lynx were 13 times less likely to cross the Trans-Canada Highway relative to random expectation, but only 2.2 and 3.1 times less likely to cross smaller highways (93 and 1A, respectively). In southeastern British Columbia, lynx avoided crossing highways within their home ranges (Apps, 2000). Squires *et al.* 2013 (p. 194) documented 44 radio-collared lynx with home ranges within an 8 km buffer of 2-lane highways, however, only 12 of these individuals crossed the highway (Squires, unpublished data).

Paved highways also pose a risk of direct mortality to lynx and may inhibit lynx movement between previously connected habitats. If lynx avoid crossing highways, this could lead to a loss of effective habitat within a home range and reduced interaction within a local population (Apps *et al.* 2007). Lynx and other carnivores may avoid using habitat adjacent to highways, or become intimidated by highway traffic when attempting to cross (Gibeau and Heuer 1996, Forman and Alexander 1998).

Carnivores are especially vulnerable to highway-caused mortality in areas with dense and high traffic volume roadways (Clevenger *et al.* , 2001). As the standard of roads increases from gravel to 2-lane or 4-lane highways, traffic volumes and the degree of impact are expected to increase. Walpole *et al.* (2012, p. 770) found that small logging roads with low traffic volume had no effect on lynx distribution. Four-lane highways, such as the interstate highway system, commonly have fences on both sides, service roads, parallel railroads or power lines, and impediments like "Jersey barriers" that make successful crossing more difficult, or impossible, for wildlife (ILBT 2013, p. 78). Alexander *et al.* (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. In Colorado, lynx successfully and repeatedly crossed major highways, including I-70 (J.Squires, personal communication 2012; Ivan 2011b, c, 2012). Colorado lynx crossed two-lane highways an average of 0.6 times per day and more frequently during dusk and night when traffic volume was lower (Baigas *et al.* 2017, p. 204). They also crossed 4-lane highways (I-70), especially forested areas under large, elevated bridges that spanned streams (Baigas *et al.* 2017, p. 204).

Between 2000 and 2015, 54 lynx were reported to have been killed on roads (both paved and unpaved) in Maine (J. Vashon, Maine Department of Inland Fisheries and Wildlife, unpub. data), 11 in Minnesota (T. Smith, U. S. Fish and Wildlife Service, unpub. data), 1 in Idaho and 5 in Montana (compiled by K. Broderdorp, U.S. Fish and Wildlife Service, unpub. data 2016). Between 1995 and 2011, 15 lynx were reported killed on British Columbia highways (British Columbia Wildlife Accident Reporting System 2012). Most of these mortalities are on higher speed paved highways. However, in Maine, about 41 percent (22 of 54) were killed on lower speed dirt logging roads.

Translocated animals may be more vulnerable to highway mortality than resident lynx (Brocke *et al.* 1990), because they often move extensively after their release and are unfamiliar with their surroundings. In the Adirondack Mountains of New York, an attempt to reintroduce lynx failed and 18 of 37 mortalities of translocated animals were attributed to road kills (Brocke *et al.* 1990). Over a 7-year period in Colorado, 13 of 102 documented mortalities of translocated lynx were killed on highways (Devineau *et al.* 2010). Traffic volumes on Colorado highways where the 13 lynx mortalities occurred were estimated to range from about 2,300 to >25,000 vehicles per day (K. Broderdorp, personal communication 2012).

Roads of all sizes have many indirect effects to lynx including increased human access (e.g. trapping and illegal shooting), and creating edge habitats that promote co-occurrence with competitors like coyotes and bobcats (Bayne *et al.* 2008, p. 1195).

Vegetation Management - As described in section 3.3, above, forest management can further fragment boreal forest in the northern contiguous United States affecting habitat suitability for both snowshoe hares and lynx. Large-scale forest fragmentation or maturation can be deleterious to snowshoe hares because they become increasingly restricted to small patches with adequate cover, and higher predation rates from a variety of carnivores tend to increase

local extinction risk (Wolff 1981, Keith *et al.* 1993, Wirsing *et al.* 2002; see also Barbour and Litvaitis 1993).

Although some forest management can benefit lynx by creating or maintaining a shifting mosaic of lynx habitat, it can also be detrimental by fragmenting habitat into small, widely-spaced parcels. Changes to vegetation structure can increase landscape resistance to lynx movements (Squires *et al.* 2013). In Montana, fragmentation from forest thinning decreased the probability of lynx movements across the forested landscape (Squires *et al.* 2013, p. 192). Lynx in the Northern Rockies are sensitive to changes in forest structure and tend to avoid large forest openings (Koehler, 1990; Squires *et al.* , 2010) like recent clearcuts and thinned areas. In Maine, the shift to partial harvesting forms of forest management will continue to increase the number of patches of high quality hare habitat, but it will greatly reduce the size of patches and increase their isolation (Simons-Legaard *et al.* 2016, pp. 5-6). This is diminishing landscape conditions conducive to supporting lynx.

Residential and Commercial Development - Residential and commercial development is increasing on private forest lands. Increased traffic and urbanization are projected for the Northern Rockies (Hansen *et al.* 2002) and Maine (section 5.1.1). It is uncertain to what degree lynx can tolerate habitat fragmentation from roads and forest clearing, and how human and pet activity affect lynx use of habitats. Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat *et al.* 2000). The degree to which residential development and associated roads reduce connectivity of mesocarnivore populations (including lynx) likely depends on the physical design of highway improvements, the surrounding environmental features, the density of increased urbanization, and the increased traffic volume (Clevenger and Waltho, 2005; Grilo *et al.* 2009).

Ski Resorts - Ski areas have similar effects on permanent habitat loss and fragmentation. One ski run is often separated from the next only by small inter-trail forest islands. Ski runs often are intermixed with other open areas such as open or gladed bowls, rock outcrops, or barren tundra ridges. Ski resorts that are built or expanded in lynx habitat may impact lynx by removing forest cover, reducing the snowshoe hare prey base, and creating or increasing human disturbance in or near linkage areas. There is limited information on lynx behavior and habitat use in and around ski areas. Lynx have been known to incorporate smaller ski resorts within their home ranges, but may not utilize the large resorts. Preliminary information from an ongoing study in Colorado suggests that some recreational use may be compatible, but lynx may avoid some areas with concentrated recreation use. In some areas, lynx habitat may be limited and concentrated in the ski area development footprint (J. Squires, personal communication 2012).

More than 50 ski areas exist throughout the range of the lynx in the contiguous U.S. (ILBT 2013, pp. 82-83). Most ski areas are located on north-facing slopes, where ample snow conditions provide for extended ski/snowboard recreational seasons. In the western states, many of these landscapes feature spruce-fir forests. While ski resorts occupy a small proportion of the landscape, spruce-fir forests provide important habitat for snowshoe hares and lynx at the

southern extent of their range. In winter, alpine and Nordic skiing and snowboarding are the primary uses. Most of these resorts offer year-round recreation, with summer activities typically including hiking and mountain biking.

Mining Leasable Minerals - Activities associated with exploration and development of leasable minerals occur primarily in western units of the DPS. Very little mining development occurs in Minnesota and northern Maine. Mining affects lynx habitat by changing or eliminating the native vegetation, human disturbance, and contributes to habitat fragmentation. Development of a high density of wells, as is typical of coal-bed methane development (e.g., 1 well per 2–4 ha [5–10 ac]), could affect lynx by directly removing habitat or causing sufficient human presence to displace lynx. The development of associated roads, powerlines, and pipelines to facilitate exploration and development also result in a loss of lynx habitat and contribute to fragmentation of habitat. In some areas, for example in the Wyoming Range, extensive oil and gas development is occurring within lynx habitat.

Locatable Minerals - Only a fraction of the historical number of mines is operating today. Those that continue to operate do so with more stringent environmental protection measures. However, in some parts of the United States, minerals exploration and new development seem to be increasing. Activities associated with exploration and development of locatable minerals could affect lynx habitat by changing or eliminating the native vegetation, and by contributing to habitat fragmentation. The effects can be variable depending on the size of the associated mining operation or development. Locatable minerals are extracted through both open pit and sub-surface mines with potential habitat alteration ranging from tens to thousands of hectares. In some instances, such as larger mining operations, land exchanges are conducted to consolidate private ownership of the surface above a deposit prior to mine development. Depending on lands exchanged this could retain lynx habitat in public ownership, but could still result in a net loss of habitat. Development of road and railroad access to facilitate exploration and development also directly impact lynx habitat, contribute to fragmentation, facilitate increased competition as a result of snow-compacted routes, and result in direct mortality. Despite these potential effects, mining exploration and development is generally anticipated to affect only a small portion of lynx habitat in the contiguous United States.

Salable Minerals - In general, salable minerals are found close to the surface. During exploration activities, equipment is moved to the site and a number of test pits are dug or holes drilled to determine the quality of material. If desired minerals are found in suitable quantity, then vegetation is removed and materials are excavated. For example, gravel pits are needed for logging road development and maintenance and are common occurrences throughout areas of the DPS that are in active forest management. Areas developed for salable minerals can vary in size from a single truck load to tens of acres. Impacts to lynx include the potential alteration or removal of lynx habitat, increased fragmentation, and the potential for human-caused mortality from road development.

Wind Energy - Wind energy development and associated transmission lines in lynx habitat is increasing across the nation. Facilities are located on ridge tops or other areas exposed to

consistent wind. The construction of wind facilities including access roads may result in loss of lynx habitat and increased fragmentation from permanent forest clearings. Noise and human activity associated with the construction and operation of wind facilities could disturb or displace lynx from important habitats. Effects would likely continue through the life of the project, which may exceed 20 years.

Utility Corridors - Utility corridors contain developments such as overhead or buried powerlines and gas pipelines, and often are located within or adjacent to existing road rights-of-way. Utility corridors potentially could have short- or long-term impacts to lynx habitats, depending on location, type, vegetation clearing standards, and frequency of maintenance. Those that are extensively cleared of vegetation and maintained in grass or herbaceous vegetation likely equate to a permanent habitat loss. When associated with highways and railroads, utility corridors may further widen the right-of-way. Utility corridors may facilitate human access into previously remote areas thus exposing lynx to increased trapping and possible illegal shooting.

Agriculture - Agricultural activity is not expanding currently in lynx habitat areas in the DPS range. In fact, in the late 1800s, over 3 million acres of northern Maine was in farming, compared to about 700,000 acres today (Ahn *et al.* 2002, p. 8). Most of the current farming is in northeastern Maine, where it fragments the forested landscape corridor between core habitats in northern Maine and western New Brunswick, Canada. Forest clearing for agriculture may have contributed (along with increasing road densities and an expansion in coyote distribution) to the recent contraction in the southern part of lynx range in eastern Alberta (Bayne *et al.* 2008, p. 1195).

Habitat Loss and Fragmentation in Corridor Areas Connecting Lynx Populations in the DPS with Adjacent Populations in Canada - Lynx conservation in the contiguous U.S. is thought to depend in part on maintaining connectivity with habitat areas and lynx populations in Canada. Maintaining connectivity for lynx may become increasingly difficult because of climate change and other anthropogenic influences, as evidenced by reduced connectivity for other boreal species (van Oort *et al.* 2011). Potential corridors have been identified in the northern Rockies (Squires *et al.* 2013, entire). There are likely broad, forested corridors with suitable dispersal habitat connecting core habitats in Maine to southern Quebec and northern Minnesota to southern Ontario. Given the perceived importance of lynx immigration from Canada to the persistence of the DPS (FR 68 40076– 40101, Squires *et al.* 2013, p. 187), roads and other forms of habitat loss and fragmentation that may impede lynx movements in the border regions of Canada and the U.S. are of concern.

Chapter 4: Current Conditions

In this chapter, we present our understanding, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the current status of the lynx DPS in terms of redundancy, representation, and resiliency. . We then provide brief summaries of the current conditions in each geographic unit, followed by a more detailed evaluation of the status of lynx populations and habitats and the factors currently believed to

influence them in each unit. Where appropriate, we compare our current understanding to what was known or believed when the DPS was listed under the ESA in 2000 and to our understanding of historical conditions.

4.1 Summary of Current Conditions DPS-wide

Because of the limitations and uncertainty in the historic records of lynx occurrence in the contiguous U.S. (described above in section 2.3.2.1), it is difficult to compare the current distribution and status of resident lynx populations in the DPS with what may have been the historical condition (but see evaluation in section 2.3.2.2, above). However, research and surveys over the last two decades have significantly improved our understanding of the current distribution, habitats, and the status of resident populations compared to what was known when the DPS was listed in 2000. For example, although we knew there were some resident lynx in Maine (Unit 1), we did not have a feel for population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS, that extensive clear-cutting in the 1970s and 1980s in response to a large spruce budworm outbreak has created the current abundance of high-quality lynx habitat, and that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain whether Minnesota (Unit 2) supported a resident population. We now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. (Units 3, 4, 5, and 6) are naturally less abundant and more patchily-distributed than was thought at the time of listing, and several areas thought to have historically supported small resident populations currently do not (the GYA [Unit 5], the Garnet Mountains in western Montana [Unit 3], and the Kettle Mountains of northeastern Washington). We also know that recent extensive wildfires in north-central Washington (Unit 4) have reduced (probably temporarily) the amount of high-quality lynx habitat and likely caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado (Unit 6), although the current number of lynx there is unknown and their distribution uncertain.

With regard to redundancy, defined as the ability of the DPS to withstand catastrophic events, we find that the current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southern Colorado. Resident breeding lynx populations currently occupy five of the six geographic units (all but the GYA; Figure 1). Of the five occupied units, four are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2) (see tables 1, above, and 4, below). Lynx experts indicated no catastrophic event that could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS and, further, no or a very low likelihood of functional extirpation of any of the individual geographic units due to a single catastrophic event (Lynx SSA Team 2016, p. 56).

Because we lack evidence that persistent lynx populations have been lost from any other large geographic areas in the contiguous U.S., it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. That is, the loss of resident lynx populations in the DPS, to the extent suggested by verified historic records, was likely in areas (e.g., northern New Hampshire, Michigan's Upper Peninsula, the Kettle/Wedge area of northeastern Washington, perhaps Isle Royale in Lake Superior) peripheral to the geographic units that currently support resident lynx. Any small populations that were lost were not in large, discrete geographic units that would have represented substantially greater redundancy in the contiguous U.S. However, the implications of the potential recent loss of resident lynx in the GYA for the redundancy of the DPS are unclear. The historic record and recent research show that the GYA has supported resident lynx. However, it is unclear whether the area consistently supported a resident breeding population over time or whether it naturally supported resident lynx only some of the time ("winked on" in a metapopulation sense) when habitat conditions and hare densities were favorable, and at other times, when habitats and hare densities were less favorable, it did not support resident lynx ("winked off" in a metapopulation sense). Given the protected conservation status of millions of -acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. If so, the contribution of the GYA to redundancy within the DPS is questionable.

Representation, defined as the ability of the DPS to adapt to changing environmental conditions, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Lynx experts and geneticists indicated high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Although hybridization with bobcats has been documented in the DPS (in Maine and Minnesota), it is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Further, despite differences in forest community types and other habitat parameters (e.g., topographic/elevation settings) lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Therefore, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. Because there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions, we find that the DPS currently displays an adequate level of representation.

Resiliency, the ability to withstand stochastic disturbance events, is currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. However, because we lack reliable estimates of the sizes and

trends of most lynx populations in the DPS, we are unable to use these parameters to evaluate the current resiliency of individual populations or geographic units. Although some demographic data (survival, reproductive rates) are available for each geographic unit (see Table 3, below), they were collected using different methods, at different times and for different intervals, and possibly at different points in hare population cycles or fluctuations and, therefore, do not provide a consistent measure of resiliency. Efforts to understand resiliency within the DPS are also confounded by the metapopulation structure thought to govern lynx populations at the southern margin of their continental range, which suggests that some populations may be naturally ephemeral (i.e., “winked on” when conditions are favorable; “winked off” when conditions are not favorable). The related uncertainty about the extent to which DPS populations may rely on cyclic immigration of lynx from Canada during population irruptions and the ambiguity in the historic record that limits our understanding of the relative persistence of lynx in various geographical areas also limit our ability to characterize, rank, or model the relative contribution of each geographic areas to the resiliency of the DPS.

Despite uncertainties and data deficiencies, qualitative factors provide some hints about current relative resiliency among some geographic areas or parts of them. For example, in Maine, lynx appear to have demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the possible extirpation of lynx populations in the GYA (Unit 5) and in the Garnet Mountains of Unit 3 may indicate the lower level of resiliency expected among small and relatively more isolated populations. The persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population; however, the post-fires increase in home range size and likely decrease in lynx numbers may indicate the population is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Overall, the apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historic conditions suggest adequate historical and recent levels of resiliency of lynx populations in the DPS.

In summary, the lynx DPS currently exhibits adequate redundancy to preclude extirpation as a result of catastrophic events. The genetic health and ecological diversity expressed across the DPS range likewise suggest a currently adequate level of representation. The long-term persistence and apparent broad geographical distribution of lynx populations in four of the six geographic units also suggests the current adequacy of resiliency in the DPS, although the potential recent extirpation of several small populations may be an indication of inadequate resiliency in those places.

4.1.1 Summaries of Current Conditions in Each Geographic Unit

Unit 1 - Northern Maine: This geographic unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) in northern Maine, but small areas of similar habitat also occur in northern New Hampshire and northern Vermont. Resident lynx in this unit are part of a larger population that also occupies southern Quebec and northern New Brunswick, Canada. At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that the largest reproducing resident population of lynx in the DPS likely occurs in this unit (numbers and trends unknown, but enough habitat exists to support possibly 500 to 1000 lynx). Small numbers of reproducing lynx have also been documented recently in northern New Hampshire and northern Vermont. Historically, lynx distribution in this unit was patchy, and lynx populations were likely low and dependent on immigration from Canada. Forest management is now the primary driver of hare and lynx habitat in this DPS unit. Current lynx and hare habitat is historically high because of young, regenerating softwood forests created by extensive clearcutting and herbiciding to salvage spruce-fir following a severe spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Lynx responded to these conditions with high survival and reproduction, small home ranges, and moderate population densities. State forestry regulations passed in 1989 caused landowners to shift to various forms of partial harvesting that have resulted in lower landscape hare densities across much of the unit. Hares do not seem to cycle in this region, but underwent a 50 percent decline starting in 2006 and have remained at lower levels. Reproduction and survival rates in the low-hare environment suggest a slightly declining population. Unlike other units of the DPS, lynx habitat in northern Maine occurs nearly entirely on private, industrial forest lands, and landowners do not have long-term commitments to lynx management. The majority of lands in Maine are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with hare and lynx habitat. Other potential stressors on private lands include large-scale wind energy development, residential and resort development, and parcelization of forestlands from rapid turnover in investment company landowners. The next spruce budworm outbreak is imminent, but forestry response by investment landowners is uncertain. Climate change is a concern as snow depth and duration are currently at the minimum thresholds believed necessary to give lynx a competitive advantage over bobcats and other mesocarnivores. There is currently no clear evidence of climate change effects on lynx distribution.

Unit 2 - Northeastern Minnesota: This geographic unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps, and black spruce or tamarack bogs. Despite uncertainty when the DPS was listed, it has become apparent that a reproducing resident population of roughly 50 to 200 lynx exists in northeastern Minnesota. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario, where trapping of lynx is legal. Lynx in Minnesota select regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites are associated with regenerating and mixed forest (Burdett 2008, p. 57). Hare densities in parts of northeastern Minnesota appear to be sufficient to support a viable lynx population; and densities

are highest in regenerating forests (McCann and Moen 2011, p. 513). The Superior National Forest continues to manage in accordance with its 2004 Forest Plan, and several risk factors are being minimized and managed to promote the conservation of lynx within the SNF. Management of lynx habitat on state and private lands is voluntary. Factors affecting current conditions in this unit primarily include forestry management, roads, incidental trapping, mining development, snow compaction, competition with bobcats, and lynx-bobcat hybridization. Forty-nine lynx mortalities due to vehicle and train collisions as well as incidental trapping and shooting have been reported in Minnesota since the species was listed.

Unit 3 - Northwestern Montana/Northeastern Idaho: There are no reliable estimates of current or historic resident lynx numbers in this geographic unit, but it is thought to be capable of supporting 200-300 lynx home ranges. Habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Minor genetic differences suggest three subpopulations in the northwest (Purcell Mountains), central (Seeley Lake), and southern (Garnet Mountains) parts of the unit. No lynx have been detected in the Garnets after 2010, but whether this indicates the extirpation of a small (7-10 individuals) previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit, including federal, State, Tribal, and some private lands, is managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire supporession) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx, with the Garnets being a possible exception. Wildfire extent has increased over the past several decades, likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Hare densities have not been estimated broadly throughout the unit but appear to be low or marginal even in most of what is considered the highest-quality habitat, suggesting that even small decreases in habitat quality/hare densities could influence its continued ability to support resident lynx. The role of past and recent immigration in maintaining the demographic and genetic health of current lynx populations in this unit is unknown, but peaks in cyclic lynx numbers in Canada have declined, especially when compared to the unprecedented irruptions of the early 1960s and 1970s, and there is no evidence of significant immigration into this unit since then.

Unit 4 - North-central Washington: This geographic unit encompasses approximately 5,176 km^2 (1,988 mi^2), 91.5 percent federally owned. It contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia, directly north of this unit, and maintaining connectivity with Canada is considered important to maintaining lynx populations in this unit. There are no reliable estimates of current or historic resident lynx numbers in this unit, but recent habitat and home range analyses (summarized in Lewis 2016) suggest that it may have been capable of supporting 65-90 lynx prior to recent large wildfires. Those fires affected about 50 percent of the potential lynx

habitat, led to increased home range size, and may have reduced the current carrying capacity of this unit to 40-55 lynx. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943). There is significant risk for potential future wildfires to further affect the viability of lynx in this geographic unit. Burned habitats are expected to regenerate back into suitable lynx habitat, but this may take 35-40 years. The Kettle Range to the east of this unit was suspected to have supported a small (likely fewer than 20 individuals) resident population until about 30 years ago when over-trapping may have resulted in its extirpation (Koehler *et al.* 2008, p.1523). Potential impediments to lynx movement between the Kettle Range and the Cascades and British Columbia may make natural recolonization of the Kettle Range unlikely. Results of snowshoe hare research suggest that the hare population density in Washington exists at the low end of the range thought necessary to support lynx reproduction (>= 0.5 hares/ha). The OWNF and CNF, which administer more than 90 percent of lynx habitat in Washington, continue to manage lynx habitat on their forests in accordance with the LCAS. Additionally, the WADNR, which manages approximately 4 percent of lynx habitat in Washington, has developed and is implementing its 2006 Lynx Plan, which is also largely based on the LCAS.

Unit 5 - Greater Yellowstone Area (GYA): There are no reliable estimates of current or historic lynx numbers in this unit but, given its naturally-fragmented potential habitat, generally low hare densities, and the paucity of verified records, it appears unlikely this unit ever supported a large resident population. No lynx have been verified in this unit after 2010, but whether this indicates the extirpation of a small but previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit consists of federal lands (97.5 %) that are currently managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx. Wildfire extent has increased over the past several decades, predominantly in the northern half of the unit and likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Snow conditions currently appear to be adequate, with most of this geographic unit modeled to have a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12). Hare densities were very low in most of Yellowstone National Park but high in parts of the Bridger-Teton National Forest in the southern half of the unit. The role of past and recent immigration in maintaining the demographic and genetic health of lynx populations in this unit is unknown. This unit lacks direct connectivity to other lynx populations, and there is only anecdotal evidence that irruptions of lynx from Canada resulted historically in immigration into this unit. Some lynx released in Colorado dispersed northward into this unit and temporarily occupied home ranges in areas used previously by native resident lynx, but there is no evidence of reproduction among these lynx.

Unit 6 - Western Colorado: Lynx habitat in Colorado is distributed west of US Interstate-25. This unit is not directly connected to lynx populations in Canada. Compared to the time of listing and completion of the Southern Rockies Lynx Amendment, two bark beetle epidemics have altered

large areas of lynx habitat in Colorado. Similarly, large wildfires have reset successional conditions in many areas. Areas affected by beetles that contained multistoried stand conditions likely continue to provide habitat to support snowshoe hares and lynx. Areas affected by beetles and fire require 20 plus years to recover to a point where the stands will again support snowshoe hares. The CPW completed their lynx reintroduction, and based on information generated during on-going studies, and reports received by CPW and the USFS, lynx continue to persist, at least in the San Juan Mountains. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell undocumented pers comm. April 4, 2016), and Rocky Mountain National Park (Shenk 2008, page 3). Habitat that supports snowshoe hares is patchily distributed in this geographic unit, which limits their abundance. Because the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. The majority of lynx habitat in Colorado continues to be managed by the USFS, providing conservation through the Southern Rockies Lynx Amendment. However, regulatory mechanisms for the conservation of lynx are lacking on approximately 3,611 km^2 (1,394 mi^2) [14 percent] of some BLM, NPS, and other non-federal lynx habitat.

Table 3. Summary of current conditions in six geographic units within the DPS range.

	Unit 1 - Northern ME	Unit 2 - Northeastern MN	Unit 3 - Northwestern MT, Northeastern ID	Unit 4 - North-central WA	Unit 5 - Greater Yellowstone Area	Unit 6 - Western CO
Unit Size (km^2)	26,909	21,101	29,997	5,176	23,687	25,294
Percent of Unit in Conservation Ownership (i.e., Federal, State, Tribal, Other Conservation Org.)	<10	75 - 90	> 95	> 90	> 95	> 90
Connectivity to Lynx Populations/ Habitats in Canada	Directly connected to lynx habitats/ populations in s. Quebec and n. New Brunswick; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Ontario; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Alberta and s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown
Home Range Size (Adult Female, km^2)	26	17 - 21	43 - 115	37 - 91	50 (1 female, 3 years)	75 - 704
Productivity – Percent Females with Kittens	89% (high hares); 30% (low hares);	100%	83% (Purcells); 61% (Seeley Lake)	100% (2 females)	Few data	24%
Productivity - Litter Size	2.74 (high hares); 2.25 (low hares)	3.3	2.95 (Purcells); 2.24 (Seeley Lake)	2.25 (2 females)	3.0 (1 female, 2 years)	2.75
Average Annual Adult Survival Rate	0.80 (high hares); 0.71 (low hares)	0.75 - 1.00	0.85 (Purcells); 0.75 (Seeley Lake)	0.86	Few data	0.93 (in Core Release Area [CRA]), 0.82 (out of CRA)
Lambda (Annual Rate of Population Change)	1.16 (high hares, 6 yrs); 0.88 (low hares, 4 yrs)	No estimate	1.16 (Purcells, 4 yrs); 0.92 (Seeley Lake, 8 yrs)	No estimate	No estimate	No estimate

4.2 Current Conditions - Detailed Descriptions by Geographic Unit

4.2.1 Unit 1 - Northern Maine

The “Northern Maine unit” includes the core, occupied habitat in northern Maine, which is designated critical habitat. It also includes areas where lynx have recently occurred in western and eastern Maine and northern New Hampshire and Vermont. To be consistent with the Workshop Report, we refer to this collective region as the Northern Maine unit.

Unit Description: This unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) primarily in northern Maine, but also small areas of northern New Hampshire and Vermont. Climate in this region is characterized by warm summers and some of the coldest temperatures and highest snowfalls in the eastern U. S.; a function of latitude, elevation, and distance from the ocean. The average terrain rises in northern Maine to 1,000-1,500 feet with mountain peaks, particularly in western Maine, northern New Hampshire and Vermont from 3,000 to 5,000 feet. This region is far enough inland to be unaffected by marine influences. Annual precipitation is 41 inches (104 cm), with greatest precipitation in winter in the form of snow 228 cm to 280 cm (90 to 110-plus inches), with higher amounts at higher elevations. Snow duration is about four months (mid-November through mid-April).

Maine - Much of the lynx habitat in northern Maine occurs within the designated critical habitat boundary, which is approximately 28,909 square kilometers (11,162 square miles) all in northern Maine (79 FR pp. 54823-54828). Land ownership in the critical habitat unit boundary is about 92 percent private, 7 percent State (primarily Baxter State Park), 1 percent tribal (Passamaquoddy Tribe, Penobscot Indian Nation), and contains no federal land. Private lands are almost entirely commercial forest lands. Lynx regularly occur outside of the designated critical habitat boundary in parts of eastern and western Maine and, recently, in northernmost New Hampshire and Vermont (see below).

New Hampshire - Habitat in northern New Hampshire is not within the designated critical habitat. Potential habitat is limited (Hoving 2001, p. 59), and the few habitat patches that support lynx in New Hampshire are much smaller than those in northern Maine (Litvaitis and Tash 2005, Fig. 2 and p. A–298; Robinson 2006, Fig. 3.3, p. 99). Hoving (68 FR 40086) estimated approximately 1,000 square kilometers (386 square miles) of potential habitat having a greater than 50 percent probability of being occupied by lynx. Litvaitis and Tash (2005, p. A–298) estimated that New Hampshire contains about 342 km2 (888 km2) of potential Canada lynx habitat. Historic distribution in New Hampshire included Coos and northern Carroll and Grafton counties (i.e. White Mountain National Forest; Siegler 1971, Silver 1974, Hoving *et al.* 2003). Habitats with the highest probability of occurrence are in Pittsburg in northern New Hampshire and the White Mountain National Forest in the central area of the state (Siren 2014, p. 34). The majority of the habitat in northern New Hampshire is located on the Connecticut Lakes Natural Area WMA which is owned and managed by NHFG. Surrounding habitat is owned and managed by the Connecticut Lakes Timber Company under a conservation easement held by the State of NH. Occurrence records from the past 10 years have been

centered on these two ownerships (Kilborn 2015, App. A pp. 42-43). Habitat on the Connecticut Lakes Natural Area has a conservation easement with 15,000 acres of the core lynx habitat also being part of an unmanaged area of the 25,000 acre property. As a result these core 15,000 acres will be allowed to mature to a climax forest type potentially allowing for good denning habitat but restricting the amount of snowshoe hare habitat in the foreseeable future. Current conditions are in a transition state, and portions of the 15,000 acres are supporting higher densities of snowshoe hare because of past forest management (Kilborn 2015, App. A pp. 42-43). Regional-scale modeling suggests that a high component of deciduous forest and insufficient snow conditions in New Hampshire are unlikely to support viable lynx populations over time (Hoving *et al.* 2005, pp. 739, 749).

Vermont - Habitat in northern Vermont is not within the designated critical habitat. Recent modeling to determine lynx habitat connectivity in the Northeast suggests that the Nulhegan River Basin contains Vermont's best lynx habitat (Farrell 2012). The 530 square kilometer (205 square mile) area is approximately 20 percent federal (Nulhegan National Wildlife Refuge), 17 percent State (Vermont Department of Natural Resources), and 63 percent private commercial timber lands (with easement). The future of lynx and their habitat is unlikely because of the patchy and limited amount of habitat, climate change (decreasing snow), trends toward hardwood management, and increasing human disturbance (Vermont Fish and Wildlife 2015, Appendix A5 p. 127).

The Northern Maine geographic unit is directly connected to lynx habitats and populations in southern Quebec and northern New Brunswick, Canada. Lynx in this unit represent the southern extent of a larger cross-border population, most of which occurs in the Gaspe region of southern Quebec and northern New Brunswick (Ray *et al.* 2002, pp. 17-20). Lynx in the northern Maine unit are geographically isolated by the St. Lawrence River from lynx populations in central Quebec (120 km north of Maine). Lynx populations in Maine and eastern Canada are geographically isolated from other lynx populations on the island of Newfoundland (900 km east of Maine), and on Cape Breton Island, Nova Scotia (650 km southeast of Maine) (Koen *et al.* 2015, entire). The closest lynx population in the DPS is located in northeastern Minnesota, about 1,700 km west of Maine.

Habitat Description: In the northern Maine unit, most lynx occurrence records are found within the broadly described ''Mixed Forest-Coniferous Forest-Tundra'' cover type (68 FR, p. 40086). This habitat type occurs along the northern Appalachian Mountain range from southeastern Quebec, western New Brunswick, and western Maine, south through northern New Hampshire. This habitat type becomes naturally fragmented and begins to diminish to the south and west, with a disjunct segment running north-south through Vermont, and a patch of habitat in the Adirondacks of northern New York (McKelvey *et al.* 2000b, pp. 248-250). This area is part of the Acadian Forest Region (Rowe 1972, p. 112-129) representing a transition between northern boreal spruce and balsam fir and southern temperate deciduous forests (Seymour and Hunter 1992, pp. 3-4). Northern Maine is characterized by low-relief, hilly terrain, but with some higher elevations up to 1,600 meters (Katahdin highlands, western Maine, White Mountains in central New Hampshire). Higher elevations support a predominantly coniferous forest (white, red, and

black spruce; balsam fir; eastern white pine) intermixed with northern hardwoods (red maple, aspen, white birch, sugar maple, beech, and yellow birch). Lowland areas include spruce-fir flats interspersed with peatlands (black spruce, tamarack).

Current lynx and hare habitat are associated with spruce-fir stands repeatedly harvested for forest products. Hares and lynx are associated with stands of regenerating sapling (15–35 years old) spruce-fir forest that provide dense cover (Robinson 2006, pp. 26–36; Vashon *et al.* 2012, p. 15). Lynx are more likely to occur in large (100 square kilometer, 40 square mile) landscapes having a high percentage (>27 percent) of regenerating forest, and less likely to occur in landscapes with very recent clearcut or partial harvest (Hoving *et al.* 2004, pp. 291–292, Simons-Legaard *et al.* 2013, entire). Regenerating stands used by lynx generally develop after forest disturbance (almost exclusively logging) and are characterized by dense horizontal structure and high stem density within a meter of the ground. These habitats support the highest snowshoe hare densities (Homyack 2003, p. 63; Fuller and Harrison 2005, pp. 716, 719; Vashon *et al.* 2005a, pp. 10–11). At the stand scale, lynx in northwestern Maine selected older (11- to 26-year-old), tall (15 to 24 feet (ft) (4.6 to 7.3 meters (m)) regenerating clearcut stands and older (11- to 21-year-old) partially harvested stands (Fuller *et al.* 2007, pp. 1980, 1983–1985). At the home range scale, lynx also select landscapes having some mature conifer forest (Simons-Legaard *et al.* 2013, pp. 572–573). Lynx may select partial harvested and mature conifer stands because of increased ease of travel and prey access along the extensive edges with high-quality (regenerating clear-cut) habitats (Simons-Legaard *et al.* 2013, p. 574).

Most of the high-quality hare and lynx habitat in northern Maine is the result of extensive landscape-scale clearcut timber harvesting in response to a spruce budworm outbreak in the 1970s–1980s (Simons 2009, pp. 64, 218). Some of these clearcuts were also treated with herbicides to promote conifer regeneration by suppressing deciduous tree species. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). Historically, the natural disturbance regime (fires, windthrow, insect outbreaks) resulted in smaller, more frequent disturbances and long intervals between larger disturbances.

Snowshoe hare populations in Maine do not seem to cycle at 10-year intervals, but have experienced a period of high (1995-2005) and low (2006 to present) populations (Scott 2009, pp. 1-44, D. Harrison, UMaine, unpub. data, Vashon *et al.* 2012, p. 14). Prior to 2006, several estimates of hare densities in the highest quality, regenerating conifer or mixed forest averaged 1.9 (Homyack *et al.* 2007, p. 8) to 2.1 hares/ha (Robinson 2006, p. 26,). After 2006, hare densities declined by about half in all stand types and have remained at these lower levels (Scott 2009, p. 109, D. Harrison, UMaine, unpub. data). Similar trends were observed in the Gaspe Region of Quebec (Assells *et al.* 2007, entire). In 1990, hare densities in dense, regenerating spruce-fir stands in New Hampshire were 0.5 hares/ha at low and high elevation (Brocke *et al.* 1990, p. 61). More recently, Siren *et al.* (2015) reported lower densities in New Hampshire (0.25 to 0.36 hares/ha) in both montane and lowland spruce-fir. Densities in high elevation (krumholtz, stunted spruce-fir) were only 0.19 to 0.28 hares/ha. Comparable hare

density data are not available for Vermont or New York. The average landscape hare density in home range-sized areas occupied by lynx in Maine was 0.74 hares/ha (Simons-Legaard *et al.* 2013, p. 567). Based on these observations, Simons-Legaard *et al.* (2013, p. 576) recommended maintaining landscape hare densities of at least 0.74 hares/ha (or 27 percent of 100 km2 areas in high-quality hare habitat) to conserve lynx.

Habitat Status: As elsewhere in the DPS, boreal spruce-fir forest habitats in the northern Maine unit are patchily distributed and intermixed with northern hardwoods, riparian areas, and peatlands. USFS forest inventory data indicate that four million acres of forestland are classified as spruce-fir in Aroostook, Penobscot, Piscataquis, and Somerset Counties in northern Maine (McWilliams *et al.* 2005, p. 122), although not all of this forest type is in areas occupied by lynx. In a 10 million acre area in northern Maine (approximately 50 percent of the designated critical habitat), Simons-Legaard (2016, p. 9-10) estimated that approximately 950,000 acres (9.5 percent) of spruce-fir was in a young, regenerating stand condition that provide high quality hare habitat. This habitat is similar to, and contiguous with, forested areas in Quebec and New Brunswick, Canada that support lynx (Hoving *et al.* 2005, pp. 740-741). The current range of lynx in the northern Maine unit is associated with areas of deep snowfall, extensive (100 km2 [40 mi2]) forested landscapes, and areas having a high proportion of regenerating conifer-dominated forest that had previously been treated with herbicides to suppress hardwoods (Homyack 2003, p. 2; Hoving *et al.* 2004, p. 287).

Lynx habitat in the northern Maine unit is associated with large-scale, intensive forest management (Harper *et al.* 1990, entire; Hoving *et al.* 2004, pp. 291-292; Simons 2009, p. 8; FR 74 8616–8701). Patches of boreal forest in New Hampshire, Vermont, and New York are more highly fragmented and smaller than in northern Maine. These more southerly forests also contain a higher proportion of northern hardwood. These forests are believed to lack the conifer component needed to produce sufficient snowshoe hare densities to consistently support viable populations of lynx (Hoving *et al.* 2005, p. 749, Carroll 2007, p. 1100).

During winter, lynx primarily selected tall (4.4–7.3 m [14.5–24 ft]) regenerating clearcuts and partially harvested stands that were 11–21 years post-harvest (Fuller *et al.* 2007, pp. 1984-1985). Lynx avoided mature stands (>40 years old) and short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partially harvested stands <10 years post-harvest (Fuller *et al.* 2007, pp. 1275-1278). Further research of year-round habitat use yielded similar results, with lynx preferentially using conifer-dominated sapling stands that were 3.4–7.3 m (11–24 ft) in height and supported high densities of snowshoe hares (Vashon *et al.* 2008b, pp. 1492-1495). Lynx tended to forage in areas with intermediate to high snowshoe hare densities (tall regenerating or older partial harvest stands), which afforded lynx with greater mobility and where snowshoe hares were more vulnerable to predation, rather than in the densest stands (short regenerating stands; Fuller and Harrison 2010, pp. 1276-1278).

Denning habitat included various types of coarse woody debris; blowdown, deadfalls, and root wads. In northern Maine, the majority of natal dens (12 of 26) occurred in conifer-dominated

sapling stands, and 6 dens were found in mature or mixed multi-story forest stands dominated by conifers (Organ *et al.* 2008, pp. 1515-1517).

In general, landscape scale and home range scale habitat selection by lynx on industrial forest lands reinforce the importance of dense regenerating conifer forest along with a component of mature conifers (Hoving *et al.* 2004, p. 286; Vashon *et al.* 2008a, pp. 1494-1495, Simons 2009, pp.64-110; Simons-Legaard *et al.* 2013, p. 568). Simons-Legaard *et al.* (2013, p. 573) found the probability of lynx occurrence was >50 percent when snowshoe hare landscape densities were >0.74 hares/ha (0.39/ac) and there was >10 percent mature conifer forest. In Maine, lynx selected softwood-dominated (spruce and fir) regenerating stands (Fuller *et al.* 2007, pp. 1983-1985; Vashon *et al.* 2008a, pp. 1492-1495) and adjacent older (11–21 years post-harvest) partially-harvested stands (Fuller *et al.* 2007, pp. 1983-1985). Lynx were more likely to occur in landscapes with abundant regenerating forest, and less likely to occur in landscapes dominated by recent clearcut or partially harvested stands (Hoving *et al.* 2004, pp.289-292). Regenerating stands used by lynx typically developed 15–30 years after harvest (Hoving *et al.* 2004, p. 291), and were characterized by high stem density and dense horizontal cover within 1 m (3 ft) of the ground (Robinson 2006 pp. 33-35, Scott 2009, pp. 81-93; Fuller and Harrison 2010, p. 1276-1278). These habitats supported high snowshoe hare densities (Homyack 2003, p. 53; Fuller and Harrison 2005, p. 716, Vashon *et al.* 2008a, p. 1492; Scott 2009, pp. 24, 32, 36-44). At a landscape scale, lynx habitat selection did not differ between sexes; however, at a home range scale, males tended to use more mature forest dominated by conifers than females, and both male and female lynx tended to avoid mature forests that had a high deciduous component (Vashon *et al.* 2008a, pp. 1492-1493).

Historically lynx habitat in the northern Maine unit was likely uncommon. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). In the Northeast prior to European settlement, lynx habitat was created and maintained by frequent, small-scale forest gap dynamic events and infrequent, large-scale stand-replacing forest disturbances (Seymour *et al.* 2002, pp. 359-365; Lorimer and White 2003, pp. 54-58). Higher elevation boreal forests are often characterized by an even-aged wind-throw phenomenon known as fir-waves (Sprugel 1976, entire). Large, stand-replacing events (fire, wind and ice storms, insect outbreaks) are rare (interval of several hundred to several thousand years) and highly variable in size (Seymour *et al.* 2002, entire; Lorimer and White 2003, pp. 50, 54, 59). Spruce budworm, spruce beetle, beech bark disease, and sugar maple defoliators have been important influences affecting forest landscape patterns (McNab and Avers 1994, Chapter 14). The frequency and intensity of spruce budworm outbreaks, the most likely insect to affect lynx habitat, have been highly variable in Maine and eastern Canada in recent centuries (Blais 1983, entire). In this geographic area, wildfire is less significant as a natural agent of disturbance. The typical fire regime is infrequent surface fires in the dormant season in the hardwood forests, and slightly more frequent but long-interval fires in conifer forests (Kilgore and Heinselman 1990, entire; Seymour *et al.* 2002, pp. 359-365, Lorimer and White 2003, p. 59). For the past several decades, early successional forests and lynx habitat in northern Maine, New Brunswick, and

southern Quebec have been created almost exclusively by forest management (Lorimer and White 2003, pp. 42-43).

In contrast, current habitat is likely peaking and at historical highs. Favorable habitat conditions for snowshoe hare and lynx in Maine resulted from large-scale salvage cutting (clearcutting) following a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, p. 291). After salvage harvest of the affected trees, a portion of the area was sprayed with herbicide to reduce deciduous competition (Scott 2009, pp. 7, 14). The resulting vegetation was dominated by balsam fir and red or black spruce (Scott 2009, p. 60). This created favorable habitat conditions for snowshoe hares and lynx. Habitat conditions for hares and lynx in the unit improved from the late-1980s to present, benefitting from stand-replacing salvage harvests during the last budworm outbreak (Simons 2009, pp. 122-229; Simons-Legaard *et al.* 2016, entire). During this time period, the percentage of forestland with an average landscape hare density greater than 0.5 hares/ha increased 400 percent (Simons-Legaard *et al.* 2016, p. 7).

Lynx habitat will decline in the near future. In response the widespread clearcutting in the 1980s, in 1989 Maine passed the Forest Practices Act. This Act regulated clearcutting. Various forms of partial harvesting replaced clearcutting as the predominant form of forest management in northern Maine. Partially harvested stands (e.g., selection harvest, shelterwood harvest, overstory removal) have a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006, p. 29). On average, partially harvested stands support about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006, p. 26-27).

Maine's forest practices shifted dramatically after the Maine Forest Practices Act. Over 95 percent of cutting that occurs now in northern Maine is partial harvesting compared to 59 percent in 1988 (Scott 2009, p. 8; Simons 2009, pp.45-47, 69-71; Simons-Legaard *et al.* 2013). This new cutting regime supports lower landscape densities of snowshoe hares (Fuller 1999, Homyack 2003, Robinson 2006, Scott 2009).

Long-term, binding land management commitments are lacking in the northern Maine unit. Unlike federal lands, there is no requirement that private landowners comply with lynx management guidelines, and a federal nexus for review of projects is almost nonexistent. Furthermore, there continues to be high turnover in forest land ownership (Hagan *et al.* 2005, Nadeau-Drillen and Ippoliti 2006) and little funding to provide incentives or to work with private landowners. As of 2005, there were 23 landowners in northern Maine with land holdings in excess of 100,000 acres including the State, federal government (White Mountain National Forest south of lynx range), a conservation group (The Nature Conservancy), two tribes (Penobscot Indian Nation and Passamaquoddy Tribe with much land south of lynx range) and 18 private forest landowners (Nadeau-Drillen and Ippoliti 2006, p. 13).

There are short-term commitments to manage lynx habitat in the northern Maine unit. In 2003, Congress passed the Healthy Forest Restoration Act. Title V of this Act designates a Healthy Forest Reserve Program (HFRP) with objectives to: (1) promote the recovery of threatened and

endangered species, (2) improve biodiversity, and (3) enhance carbon sequestration. In 2006, Congress provided the first funding for the HFRP, and Maine, Arkansas, and Mississippi were chosen as pilot States to receive funding through their respective Natural Resources Conservation Service (NRCS) State offices. Based on a successful pilot program, in 2008, the HFRP was reauthorized as part of the Farm Bill, and in 2010, NRCS published a final rule in the Federal Register (75 FR 6539) amending regulations for the HFRP based on provisions amended by the bill.

In 2006 and 2007, the NRCS offered the HFRP to landowners in the proposed Canada lynx critical habitat unit in Maine to promote development of Canada lynx forest management plans. Since that time four private landowners, The Nature Conservancy, the Passamaquoddy Tribe, Merriweather LLC, and Katahdin Forestlands successfully enrolled in the program. Collectively, these land ownerships comprised 943.2 mi2 (2,443 km2), or 9.3 percent of the total designated critical habitat in northern Maine.

The NRCS required that lynx forest management plans must be based on the Service's ''Canada Lynx Habitat Management Guidelines for Maine'' (McCollough 2007, entire). These guidelines were developed from the best available science on lynx management for Maine. The guidelines required maintenance of landscapes having hare densities that support reproducing lynx populations. Notably, HFRP forest management plans provided a net conservation benefit for lynx, which was achieved by employing the lynx guidelines, identifying baseline habitat conditions, and meeting NRCS standards for forest plans. Plans met NRCS HFRP criteria and guidelines and complied with numerous environmental standards. Plans were reviewed and approved by the NRCS with assistance from the Service. The details of the plans are proprietary and will not be made public per NRCS policy.

Short-term commitments to lynx management will expire in 2016 and 2017. Unlike lynx forest plans on federal lands, HFRP plans lack long term commitments beyond an initial 10-year contract period. Plans were prepared for a forest rotation (70 years) and include a decade-by-decade assessment of the location and anticipated condition of lynx habitat on the ownership. However, landowners are only committed to a 10-year contract, and long-term commitments to lynx management are voluntary. Some landowners developed plans exclusively for lynx, and others combined lynx management (umbrella species for young forest) with American marten (umbrella species for mature forest) and other biodiversity objectives. All four plans have been completed and contracts with NRCS will expire in 2016 and 2017. Landowners have the option to convert HFRP contracts into Safe Harbor Agreements or other agreements to provide regulatory assurances, however, at this time this option has not been explored with landowners.

Many large private forest landowners in the northern Maine unit have commitments to endangered species management through forest certification programs. For example, The Nature Conservancy land enrolled in the HFRP is also enrolled in the Forest Stewardship Council (FSC) forest certification program, which requires safeguards for threatened and endangered species. Other landowners are certified under the Sustainable Forestry Initiative (SFI). Both certification programs require planning for threatened and endangered species.

However, certification programs are also voluntary and may not be long-term commitments. Given the frequent turnover in Maine forest lands, new landowners do not always renew certification or resume the certification programs initiated by the previous landowner.

Lynx Status: At the time of listing, lynx were known to be present in northern Maine but little was known about their distribution, population size, and trend, snowshoe hare populations, and relationships to forest management. Since then, research from the Maine Department of Inland Fisheries and Wildlife (Vashon *et al.* 2008a, entire; 2008b, entire; and 2012 entire) and the University of Maine (Hoving *et al.* 2003, entire; Hoving *et al.* 2004, entire; Hoving *et al.* 2005, entire; Homyack *et al.* 2005, entire; Homyack *et al.* 2007, entire; Homyack *et al.* 2006, entire; Fuller *et al.* 2007, entire; Fuller *et al.* 2004, entire; Fuller and Harrison 2005, entire; Simons-Legaard *et al.* 2013, entire; Simons-Legaard *et al.* 2016, entire) have greatly increased our knowledge. Snow track surveys and confirmed occurrence records (Vashon *et al.* 2012, entire; Siren 2015, entire) document that lynx occur throughout northern Maine and in small, isolated pockets in western and eastern Maine, northern New Hampshire, and Vermont (Siren 2015, entire). Population size and trends are still uncertain.

The Northern Maine Unit currently supports a breeding population of lynx that encompasses most of northern Maine, with recent lynx occurrence and reproduction also documented in northernmost New Hampshire and Vermont. This geographic unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspe region of southern Quebec. Extensive areas of contiguous forestland in this region provide high connectivity between populations in Maine and Canada. Although potential lynx habitat in New Hampshire and Vermont is fragmented, there is near contiguous forest and connectivity for lynx movement between these areas and habitats in northern Maine (Farrell 2013 personal communication, FR 54821). Breeding lynx in New Hampshire and Vermont are not directly connected to Canadian populations, but they are connected to the larger population in northern Maine via habitat in western Maine.

Lynx in the Northern Maine Unit and adjacent populations in southern Quebec and northern New Brunswick are separated from lynx populations in the interior of Canada. The St. Lawrence River restricts lynx dispersal and demographically isolates this population from those in northern Quebec, Labrador, and Ontario. However, sufficient numbers of individuals cross the river on the ice each generation to prevent genetic drift of this population (Koen *et al.* 2015).

At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that a significant population currently exists and is supported by the extensive young, regenerating spruce-fir habitat created by clearcutting in the 1970s and 1980s. Habitat in northern Maine can support lynx densities in localized areas of high quality habitat that are substantially greater than elsewhere in the DPS (LCAS 2013, p. 23). In 2003 when hare populations were high, lynx density (juveniles and adults) in one of Maine's highest quality habitats was estimated to be 9.2-13.0 lynx/100km^2 (Vashon *et al.* 2008, Vashon *et al.* 2012, p. 15). At about the same time, the density of lynx in nearby Gaspe Peninsula, Quebec was estimated to be 10 lynx/100km^2 (Ray *et al.* 2002). These densities are intermediate to those

in Canada during the high (17.0-44.9/100km^2) and low periods (2.3 – 3.0/100km^2) of the lynx-hare cycle (Poole 1994, Slough and Mowat 1996, O'Donaghue *et al.* 1997). Simons (2009, p. 102) estimated there is potential for a population of about 236 to 355 adult lynx to occur on a 3.56 million acre study area (about half of the critical habitat area) in northern Maine, and Vashon *et al.* (2012, appendix IV) estimated there is potential for a population of 750 to 1,000 adult lynx in all of northern Maine in 2006. The actual number of lynx is unknown because there are no methods available to measure and produce true population estimates over such a large geographic area.

Lynx populations in New Hampshire and Vermont may consist of only a few animals, although breeding has occurred in both locations in recent years. Most historic lynx records from New Hampshire are from trapping records from the 1930s to the 1960s (Brocke *et al.* 1993, McKelvey *et al.* 2000). There were only two records in the 1990s. In 2003, the Service determined that, despite a lack of breeding records, a small resident population likely occurred historically in New Hampshire but no longer exists (68 FR 40087). Lynx were detected in northern New Hampshire in 2006 and have occurred there annually since (Siren 2014 pp. 53, 55). In 2011, 4 lynx kittens were observed in Pittsburg and were considered evidence of breeding in New Hampshire (Kilborn 2015 Appendix A p.44). There were only four historic records of lynx in Vermont prior to 2003. Since then, nine lynx sightings have been confirmed. Reproduction was first documented in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Vermont Fish and Wildlife 2015, Appendix A5 p. 126).

Lynx do not presently occur in the Adirondacks region of New York. A resident lynx population reportedly occurred in the northern region of New York, particularly in the Adirondack Mountains, but it was considered extirpated by 1900 (Brocke 1982, McKelvey *et al.* 2000b). However, there are 23 verified lynx occurrences since 1900, primarily from the Adirondack Mountains (McKelvey *et al.* 2000b). The most recent verified record was from 1973 (McKelvey *et al.* 2000b), which correlates to an extreme cyclic population high. Habitat and prey conditions were deemed suitable for a lynx reintroduction in 1989–1991 (Brocke 1982). The reintroduction was unsuccessful in establishing a population. In 2003 the Service concluded that a resident population may have existed in New York prior to 1900, however, records of lynx since 1900 are of dispersers (68 FR 40087).

Maine lynx had spatial and demographic parameters similar to some northern populations during the cyclic high in the snowshoe hare cycle (Brand *et al.* 1976, Parker *et al.* 1983, O'Donaghue *et al.* 1997). Maine lynx had among the smallest home ranges in the DPS (LCAS 2013, p. 24). During the period when snowshoe hare populations were highest, Maine lynx had among the highest reproductive rates (average litter size 2.74, 89 percent of adult females producing litters) in the DPS (Vashon *et al.* 2012, pp. 18-19). During the current period of low hare density, litter size was smaller, only 30 percent of females have litters, and mortality is greater. Home ranges are among the smallest in the DPS (54 + 5 km2 males; 26 + 4 km2 females, LCAS p. 24, Vashon *et al.* 2008a). Home range sizes were similar during periods of high and low hare density (Mallett 2014). Lynx populations likely increased during the period of

high hare density (lambda [λ] = 1.16) and declined during periods of low hare density (λ = 0.88) (USFWS, Vortex10, deterministic population simulation 2016; demographic data from Vashon *et al.* 2012).

In summary, Maine lynx and hare habitats are at historical highs. In the Northeast prior to European settlement, lynx habitat was created and maintained by small-scale, frequent forest gap dynamic events and large-scale, infrequent (stand-replacing) forest disturbances (Seymour *et al.* 2002, Lorimer and White 2003). Historically, lynx distribution was patchy, and lynx populations were likely low and dependent on immigration from Canada. Current habitat is the result of widespread clearcutting and herbiciding to salvage spruce and fir damaged by a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Maine lynx at multiple scales select extensive areas of regenerating, dense (7,000 – 14,000 stems/ha) spruce-fir stands 15 to 35 years after clearcut or other even-aged harvest (Hoving *et al.* 2005, Fuller *et al.* 2007, Vashon *et al.* 2008, Simons-Legaard *et al.* 2013). Lynx habitat is expected to remain stable for the next few years then decline (Simons-Legaard *et al.* 2016).

Factors Affecting Current Conditions: *Climate Change* - Climate change is affecting temperature, snow, and precipitation patterns in the Northeast at rates faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46^{o} C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Climate change has, and will continue to affect lynx by reducing snow and boreal forest (see section 5.1.1).

Snow Duration, Depth, and Quality - As noted in chapter 2, lynx occur where there is regularly at least four months (120 days) of continuous snow coverage (Gonzales *et al.* 2007). Snow cover days in northern New England (1965-2005) ranged from 60-121 days and declined an average of 3.6 days/decade from 1965-2005 (Burakowski *et al.* 2008). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Thus, average conditions in Maine are currently at or below the snow persistence thresholds believed to be needed to support lynx (Gonzales *et al.* 2007). Similarly, the largest snow depth decreases in Canada in the last six decades have been observed in the lower St. Lawrence Valley, immediately north of Maine (Brown and Braaten 1998, pp. 48-52).

Lynx in the Northeast and eastern Canada occur where there is regularly total snowfall of at least 270 cm/yr (106 in/yr; Hoving *et al.* 2005), which defines the distribution of lynx and bobcat in this region (Hoving *et al.* 2005, Carroll 2007, Peers *et al.* 2013). Average annual snow depth at 5 weather stations within the range of the lynx in northern Maine (1981-2010) was below this threshold, 228-263 cm (NOAA 2011, http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html, last accessed 31 March, 2016). In the last 50 years, 18 of 23 snow sampling sites in and near Maine experienced reduce depth of snowpack (Hodgkins and Dudley 2006). Snow depth in New England (1965-2005)

declined an average of 4.6 cm/decade (Burakowski *et al.* 2008). Thus, average snow conditions in Maine are currently at or below this snow depth threshold, and further declines in annual snow depth would be expected to give bobcats a competitive advantage over lynx (Hoving *et al.* 2005,)

As noted in chapter 2, lynx and snowshoe hare require deep, fluffy snow that provides lynx with a competitive advantage over bobcats and gives hares the ability to reach winter browse. Snow quality ("fluffiness") has deteriorated in the Northeast. Unlike other units, annual precipitation in Maine is increasing because of climate change, but primarily as rain (A. Siren *in* Lynx SSA Team 2016, p. 15; Fernandez *et al.* 2016), and especially rain on snow events in winter in northern Maine (Huntington and Hodgkins 2004, Deser *et al.* 2013, Fernandez *et al.* 2015). Snow density and compaction and crust conditions (caused by wet, heavy snow or rain on snow events in winter) have increased in northern New England (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006) and southern Canada (Karl *et al.* 1993).

Vegetation Management - The effects of forest management on foraging and denning habitat for lynx in northern Maine are discussed in the Habitat Description and Habitat Status sections above.

Wildland Fire Management - Although fire is frequent in many boreal forest regions, it is not a stressor for lynx in northern Maine. Annual precipitation is comparatively greater in this unit than others, and conditions for fire are infrequent. The fire regime in this unit is infrequent (50- to 200-year interval) and generally small (several acres) surface fires in the dormant season. Large (up to 80,000 acres) stand-replacing fires are rare and occur at a less frequent interval (800- to 9000-years) (Seymour *et al.* 2002 p. 360). In contrast, spruce budworm outbreaks cause stand-replacement over large areas every 100–250 years (Cogbill, 1985).

Habitat Fragmentation - Habitat fragmentation (smaller and more isolated patches of high quality hare habitat) caused by current forest practices in northern Maine is discussed in the Habitat Description and Habitat Status sections above.

Other Factors: *Trapping* - This unit is directly connected to lynx habitats and populations in southern Quebec, where trapping of lynx is legal. Several lynx that were captured and radio-tagged in northern Maine were subsequently trapped in southern Quebec (Vashon *et al.* 2012).The lynx trapping season was closed in the Northern Maine Unit (including New Hampshire and Vermont) for decades prior to lynx being listed as a threatened species. Carroll (2007) modeled lynx populations in this unit and demonstrated that increased trapping pressure in Quebec could have a negative effect on protected lynx populations in Maine and New Brunswick. About 400 lynx are trapped and killed annually in Quebec south of the St. Lawrence River (http://mffp.gouv.qc.ca/english/wildlife/statistics/index.jsp last accessed May 19, 2016). In 2014, the Maine Department of Inland Fisheries and Wildlife (MDIFW) obtained an incidental take permit from FWS for lynx trapped incidental to other furbearer trapping in Maine. From 2000 to 2015, 108 lynx have been reported captured in traps set for other species and 7 of

those were killed (Vashon *et al.* 2012, MDIFW 2014, p. 75). No lynx have been reported incidentally trapped in New Hampshire or Vermont since 2000. In Maine, after two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions (e.g., requiring killer-type traps be placed in exclusion boxes, eliminating the use of drag sets for foothold traps) to further reduce mortality and injury of incidentally-trapped lynx.

Trapping of Canada lynx can be additive to other sources of mortality and have population-level effects (Brand and Keith 1979, Koehler and Aubrey 1994). Thus, harvest regulations for lynx are modified when hare and lynx populations are low (Bailey *et al.* 1986). Trapping mortality is not likely to have a great effect on lynx populations in northern Maine and adjacent Canada when lynx are at historically high numbers, but trapping could have a synergistic and negative effect if hare and lynx populations decline, habitat declines, or climate change further stresses lynx (Slough and Mowatt 1996, Carroll 2007).

Wind Power Development - In response to climate change, wind development has escalated in northern and western Maine posing a potential threat to high and low elevation spruce-fir habitats (Whitman *et al.* 2013). Climate conditions are at or falling below threshold values needed to support lynx in Maine (see section above). Maine has experienced a rapid increase in wind energy development (http://www.eia.gov/electricity/data/browser, last accessed August 2, 2016), and there is increased interest in placing developments on private lands in unpopulated areas throughout northern Maine, New Hampshire, and Vermont. Wind energy is an increasingly appealing source of income for investment companies and other landowners who own forestland in the northern Maine unit. As of 2016, at least 11 wind projects have been proposed in northern Maine and 5 projects are in operation; 2 have been proposed in northern New Hampshire and 2 are in operation; and 3 have been proposed for northeast Vermont and 2 are in operation or under construction. Maine's two largest wind projects (combined over 200 turbines covering 360 mi2) are proposed entirely within Maine's lynx critical habitat. The effects of wind energy projects on lynx, hares and their habitat are undocumented. Potential direct effects include disturbance or displacement of resident lynx and loss and fragmentation of habitat from turbines, roads, and transmission lines. Increasing power infrastructure associated with these projects could greatly change development potential and patterns in northern Maine by bringing electricity into the interior of Maine's vast, undeveloped forest region. Extensive road construction further fragments habitat and increases access for recreation, including trapping.

Changing Land Ownership and Development - Until recently, the northern Maine unit was largely undeveloped, industrial forestland, but land ownership patterns have changed significantly in the last 15 years (Nadeau-Drillen and Ippoliti 2006). Some investment-oriented landowners are seeking diversified financial returns on their investment, including developing residential housing, second homes, and resorts. Two large residential and resort areas have been proposed on forestlands within the Maine critical habitat area. Both development projects would result in the development of several thousand acres of potential lynx habitat, but would be mitigated by substantial (100,000s of acres) conservation easements on surrounding forestland. Another private landowner proposes donation of a 87,000 acres within the lynx critical habitat for a federally-designated national park or monument. This area currently has a legacy of

young-regenerating spruce-fir habitat from previous industrial forest landowners, but a park or monument designation would forego future forest management. Another conservation landowner, The Nature Conservancy, continues forest management on about half of its 185,000 acre ownership, including managing part of the area for Canada lynx.

Construction or expansion of developed areas such as residential areas and resorts, as well as smaller recreational sites like nordic ski huts or campgrounds, may directly remove forest cover. Such removal in lynx habitat could decrease prey availability, affect lynx movement within home ranges, or result in a more fragmented landscape. Development further fragments habitat from road and highway construction (along with associated increases in traffic volumes and/or speeds).

Northern Maine Unit Summary - In summary, lynx are currently widespread throughout northern Maine and in small patches of habitat in northern New Hampshire and Vermont. Habitat exists to support a potential population of 500 to 1000 lynx, although the actual population size is unknown. Habitat created by extensive clearcutting 30 to 40 years ago is peaking and will decline by 50 percent in the next 15 to 20 years (Simons-Legaard 2016, p. X; also see section 5.1.1, below). Furthermore, hare populations declined by 50 percent starting in about 2006 and have remained at lower levels. Future hare fluctuations or cycles are uncertain. Active management of forest lands can produce lynx habitat, but landowners do not have long-term commitments for doing so. Land ownership has dramatically changed in northern Maine, and the majority of lands are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with lynx habitat. Greatest stressors are habitat loss (shifts in forest management from clearcutting to partial harvesting resulting in lower landscape hare densities), lack of forest planning for lynx, and climate change (diminishing snow depth, quality and duration; competition from bobcats and fishers; loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing ice conditions on the St. Lawrence River).

4.2.2 Unit 2 - Northeastern Minnesota

Unit Description: This unit encompasses approximately 21,100 square kilometers (8,147 square miles) in northeastern Minnesota. It includes the area designated as critical habitat in 2014 (79 FR 54782) and an additional relatively small area of tribal land in northern Minnesota that was excluded from critical habitat. Land ownership in this unit is about 47 percent federal (primarily USFS, with some NPS and BLM land); 36 percent State; 16 percent private; and 1 percent Tribal (Grand Portage Reservation) (see Table 1). This unit includes most of Superior National Forest (SNF; including the Boundary Waters Canoe Area Wilderness [BWCAW]) and Voyageurs National Park. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario (ON). Relative to other DPS lynx populations, this unit is about 1,480 km (920 mi) east of the Northwest Montana/Northeast Idaho Unit and about 1,610 km (1,000 mi) west of the Northeastern Maine geographic unit.

Habitat Description: In Minnesota, most lynx occurrences are associated with the Mixed Deciduous/Conifer Forest (McKelvey *et al.* 2000b, pp. 246, 248) within the Laurentian Mixed Forest Province (McNab *et al.* 2005, p. 5). Most of this province is characterized by low-relief hilly landscapes with glacial features and an elevation from sea level to 2,400 feet (730 meters), including many lakes and rivers. This unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps and black spruce or tamarack bogs. Coniferous and mixed-coniferous/deciduous vegetation types are dominated by balsam fir; black and white spruce; northern white cedar; Jack, white and red pine; hemlock; and tamarack; mixed with aspen and paper birch (Burdett 2008, p.5; Moen *et al.* 2009, pp.1-2; McCann and Moen 2011, p. 510). Burdett (2008, p. 57) reported that lynx in Minnesota selected regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites were associated with regenerating and mixed forest. McCann and Moen (2011, p. 513) found snowshoe hare densities were highest in regenerating forests. Females selected large woody debris and dense horizontal cover in lowland conifer cover for denning in northern Minnesota (Moen *et al.* 2008, p. 1510), but other cover types were used if recent blowdowns were present (Moen and Burdett 2009, p. 5).

Hare density in parts of northeastern Minnesota appears to be sufficient to support a viable lynx population (Moen *et al.* 2008, p. 1512), ranging between 0.3–2.0 hares/ha (0.12–0.8 hares/ac; McCann 2006, p. 17). Hare populations in northeastern Minnesota appear to be patchily distributed, but are most consistently abundant in 10-30 year old regenerating forests (McCann 2006, p.45). Pellet count data prior to the 1990s show evidence of density fluctuations of snowshoe hare populations occupying Minnesota (Fuller and Heisey 1986, pp. 262-263), but these fluctuations were not observed during the 1990s (Hodges 2000b, p. 172). Snowshoe hare habitat in Minnesota primarily consists of conifer forests with dense low-growing understories, lowland shrub and conifer bogs. Conifer bogs or lowland conifer forests may be especially important during low points in hare cycles by acting as refugia for hares. Early regenerating or pole-sized stands are not used as much as in other portions of their range, although older regeneration stands were used frequently in Minnesota (McCann 2006, p. 45). Sapling-sized aspen adjacent to conifer cover may also provide functional snowshoe hare habitat. McCann and Moen (2011, pp. 512-513) mapped the distribution of predicted snowshoe hare habitat across northeastern Minnesota. In northeastern Minnesota, edge habitats and regenerating conifer stands appeared to be important for snowshoe hare populations (Burdett 2008, p. 58; McCann 2006, p. 45), as were dense habitats containing balsam fir, white spruce, and cedar (Fuller and Heisey 1986, p. 263). Recent research indicates that the red squirrel is not an important prey species for lynx in northeastern Minnesota (Burdett 2008, p. 62; Hanson & Moen 2008, p. 9).

Average annual snowfall in this unit ranges from about 180 cm (71 in) in the northwestern part of the unit near International Falls, Minnesota to 219 cm (86 in) in Duluth, Minnesota, on the southern end of the unit, to 228 cm (90 in) in Tofte, Minnesota, near the lake shore on the far eastern-central part of the unit, to 228 cm (90 in) in Isabella, Minnesota, near the center of the unit, to the 107 cm (42 in) in Grand Portage, Minnesota, at the northeastern tip of the unit. More

snow is produced along Lake Superior, because of the lake effect (https://snowfall.weatherdb.com/d/a/Minnesota; accessed 4/25/2016).

Habitat Status: Friedman and Reich (2005, p. 732) conducted a spatially explicit forest composition change analysis on a 3.2 million hectare study area in northeastern Minnesota, which was based on General Land Office Survey records from the late 1800s and the 1990 USFS Inventory and Analysis Survey. The study documents altered forest tree species abundance, proportional basal area, and spatial distribution patterns. The proportionally most abundant species in northeastern Minnesota shifted from the presettlement period (spruce, 21 percent; larch, 15 percent; and paper birch, 15 percent) to aspen (30 percent), spruce (16 percent), and balsam fir (16 percent) in 1990. White pine declined from 20 percent to 5 percent basal area dominance, birch from 16 percent to 13 percent, spruce from 14 percent to 9 percent, and larch from 12 percent to 2 percent, while aspen increased from 8 percent to 35 percent basal area dominance.

In 2015, the SNF estimated that there were approximately 759,700 acres (60 percent of lynx habitat on the SNF) of suitable snowshoe hare habitat on the SNF and that only 23,800 acres of habitat on the SNF was in a condition unsuitable to lynx (USDA 2016, unpublished data).

The SNF continues to manage in accordance with its 2004 Forest Land and Resource Management Plan (USDA 2004, entire). The Forest Plan emphasizes providing sustainable amounts of timber, maintaining or enhancing biodiversity, contributing to economic and social needs of the community, and managing in an environmentally sound manner to produce goods and services that provide for long-term public benefits (USDA 2004, entire). The Forest Plan includes many objectives, standards, and guidelines for the protection of lynx and enhancement of lynx habitat that are based on recommendations in the 2000 LCAS. LAUs were delineated on the SNF in 2000 as the smallest landscape scale on which to analyze effects to lynx. The boundaries have remained in place since that time to allow for long term analysis of project effects. However, the SNF Plan proposed several changes of current LAU boundaries, such as adding LAUs to the Virginia Management Unit of the Laurentian Ranger District; designating the BWCAW a lynx refugium.

This unit is directly connected to lynx habitats and populations in southern Ontario, where trapping of lynx is legal. Habitat connectivity within and between portions of northeastern Minnesota and Canada appears functional based on radio-telemetry data that have documented lynx movements between Minnesota and Ontario (Burdett *et al.* 2007, p. 458; Moen 2009, pp. 4-6; Moen *et al.* 2010b, p. 5).

Lynx Status: At the time of listing, the Minnesota population was not believed to contribute significantly to the DPS. However, we now know that a reproducing resident population exists in northeastern Minnesota. Moen (*in* Lynx SSA Team 2016) recently estimated the potential for a population of about 50 to 200 lynx to occur in northeastern Minnesota. In 2008, Moen *et al.* (2008b), estimated the number of lynx that might be resident in northeastern Minnesota at a given time as between 190 and 250 individuals, assuming that about 25 percent of northeast

Minnesota is suitable lynx habitat, coupled with assumptions about residence time and detectability. The actual number of lynx is unknown because methods have not been implemented to measure and produce precise population estimates over such a large geographic area. We have no estimates of lynx densities in Minnesota.

Home range sizes in Minnesota were reported as 194 km^2 (75 mi^2) males and 87 km^2 (34 mi^2) females (Mech 1980, p.263). Later radio-collar data show that males had much larger home ranges 267 km^2 (103 mi^2) than females 21 km^2 (8 mi^2); and that females with kittens had the smallest home range (Burdett *et al.* 2007, pp. 460-461). A study of radio-collared lynx in Minnesota documented approximately 40 percent of male and female lynx making long distance movements outside of their home range between Ontario, Canada and Minnesota (Moen *et al.* 2010b, p. 17). Of those lynx that made long-distance movements, females tended to move 62-124 miles (100-200 km) and did not return to their original home range, while males moved 31-49 miles (50-80km) back and forth between Ontario and Minnesota (Moen *et al.* 2010b, p. 17). While topographic features may influence lynx movements in mountainous western states, lynx in Minnesota tended to move nearly straight paths (Moen *et al.* 2010b, p. 13).

The SNF and others have identified 268 unique individual lynx (48 percent Female, 51 percent Male) from DNA samples taken since 2000 (Catton *et al.* 2015, p. 1). Of the 1,306 DNA samples, 1,039 were identified as lynx, however 42 samples were identified as F1 lynx-bobcat hybrids (Catton *et al.* 2015, p. 1). Of those 42 hybrids, 13 unique individual lynx-bobcat genotypes (5 Female, 8 Male) were also identified (Catton *et al.* 2015, p. 1). The DNA analyses also showed persistence of individual lynx in Minnesota of 2 years (N = 27 lynx), 3 years (N = 11), 4 years (N = 5), 5 years (N = 6), and 1 female lynx tracked for over 5 years, who produced 7 kittens in Minnesota (Catton *et al.* 2015, pp. 3-5).

Since 2000 the U.S. Fish and Wildlife Service has been tracking incidental take of lynx; 29 lynx mortalities have been reported from trapping, shooting, vehicle collisions, and railroad mortalities in Minnesota. Thus far, of 26 lynx documented to have been incidentally trapped in Minnesota, 11 died and 15 were released alive (U.S. Fish and Wildlife Service, unpublished database 2016). The documented incidents largely occurred during legal trapping that targeted bobcat, coyote, fox, and marten, and involved a variety of traps including foot-holds, body gripping traps, and snares (U.S. Fish and Wildlife Service, unpublished database 2016). In addition, seven lynx mortalities as a result of being incidentally shot have been documented in Minnesota and 16 died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Lynx emigrating from Minnesota to Ontario exposes them to trapping and shooting that is allowed in accordance with regulated harvest in Canada. At least a third of the animals radio-collared in Minnesota spent time in Ontario; 4 radio-collared lynx were legally harvested (trapped) in Canada between 2003 and 2010, and two died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Furthermore, nine lynx mortalities due to vehicle collisions have been documented in Minnesota since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). Minnesota has relatively high forest road and highway densities that intersect lynx habitat and several radio-collared lynx in Minnesota inhabited home ranges that were bisected by highways. In addition to road mortalities, two railroad mortalities

have been documented since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). It is probable that there are additional incidental catches that are not reported each year (Moen 2009).

Factors Affecting Current Conditions: Identified factors affecting to the current conditions of lynx in Minnesota include reduction in habitat quality or quantity, habitat fragmentation, climate change, increased access for competing carnivores, and human-caused mortality. The SNF is currently implementing the 2004 SNF Plan (USDA 2004, entire), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the SNF has a long-term commitment for doing so; however, private landowners do not. Under the Sustainable Forest Resource Act of 1995, the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx. The implementation of the MFRC guidelines is monitored annually (e.g., MDNR 2015, entire). Thus, the several risk factors are being minimized and managed to promote the conservation of lynx within the SNF, however implementation of the guidelines on privately owned lands is voluntary.

Activities that change forest structure can affect habitat quantity and quality for lynx and snowshoe hares, their primary prey source. Thinning and other timber management practices that reduce stem density and downed material and promote more open, mature stands can reduce habitat quality and quantity. Throughout the Superior National Forest and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Mineral exploration and development is increasing in portions of Minnesota, particularly for hard rock (non-ferrous) minerals. Some of the area of interest for minerals overlaps with lynx habitat in northeastern Minnesota. Mineral exploration may result in short-term displacement of lynx. Mining activities and associated development may result in an irreversible loss of habitat or increased mortality risk. The specific effects to lynx and their habitat will depend on the scale and type of each project.

Roads are a factor in human-caused lynx mortality where they provide access to areas where lynx occur, increasing the risk of negative interactions between people and lynx. Throughout the SNF outside the BWCAW, high and low standard roads bisect many areas that provide potential or suitable lynx habitat. Additionally, bobcat harvest in northeastern Minnesota has been increasing over the last decade (Erb 2012, unpaginated). Where lynx and bobcat overlap, there is potential for accidental shooting of lynx, or for bobcat hunting with dogs to harass or harm lynx.

Snow compacts under natural conditions; however, snow compacted by human activity may increase access by coyotes and bobcats to prey in deep snow conditions where historically they were excluded or rare. Winter road use, snowmobiling, cross country skiing, and dog sledding

all have the effect of compacting snow. Outside the BWCAW, snowmobile activity is extensive and increasing significantly. The SNF has 705 miles of snowmobile trails and 1,562 miles on all ownerships within the proclamation boundary (USDA 2011). Advances in snowmobile capabilities have raised concerns about intrusion and new snow compaction in areas previously not vulnerable to high levels of snowmobile use. In addition, new road construction in lynx habitat has made more areas accessible during winter. These routes could be used by snowmobiles even if new roads are designated as closed to motorized public travel during other seasons. The SNF has 1,927 miles of low standard roads (OML 1 and 2) and 158 miles of temporary roads (USDA 2011). All of these factors have potential to reduce the deep and fluffy winter snow conditions and to reduce the competitive advantage of lynx in areas that typically receive deep snows.

As described in Chapter 2, above, lynx are adapted for surviving in areas that have cold winters with deep, fluffy snow, where they outcompete potential competitors such as bobcats, coyotes, and wolves (Buskirk *et al.* 2000a, pp. 90-91; McCord & Cardoza. 1982, pp. 748-749; Ruediger *et al.* 2000). The geographical distribution of bobcat harvest in Minnesota has remained relatively static with a lack of harvest in the Arrowhead region of Minnesota (the region encompassed by Cook, Lake and St. Louis counties in northeastern Minnesota) (Erb 2009 cited in Kapfer 2012, p. 16, Erb 2012, pp. 7-9) and annual snow track and scent stations surveys support the conclusion that bobcats are as rare in the Arrowhead as harvest indicates (MN DNR unpublished data cited in Kapfer 2012, p. 23). However, this may change with decreased snow conditions predicted to occur due to climate change (Kapfer 2012, p. 25). Bobcat and coyote populations already appear to be increasing in Minnesota (Erb 2014, p. 40). If snow depth and duration decrease in the Arrowhead, deer mortality may be reduced which may potentially increase bobcat densities and bobcat expansion into northeast Minnesota (Kapfer 2012, p. 25). According to annual track surveys, wolf populations in Minnesota are currently stable (Erb 2014, p. 40), however, similar to bobcat, wolf populations may increase with changing snow conditions and prey availability as influenced by climate change.

Furthermore, in Northeastern Minnesota, several lynx-bobcat hybrids have been documented (Catton *et al.* 2015, p. 1), however, most bobcat records occur south and west of the core part of the lynx range in Minnesota (see figure 1.1 *in* Kapfer 2012, p. 51). Bobcat populations are increasing in Minnesota (Erb 2014, p. 40) and more bobcat-lynx hybridization may occur as a result of climate change (Koen *et al.* 2014, p. 113).

4.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Unit Description: This geographic unit includes the parts of northwestern Montana and northeastern Idaho the Service designated as critical habitat (Unit 3) for lynx in 2014 and some Tribal and State lands that were excluded from that designation (79 FR 54825). It encompasses approximately 27,000 km^2 (10,424 mi^2) in portions of Boundary County in Idaho and Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton Counties in Montana, with ownership that is 84 percent federal (USFS,NPS, and BLM); 8 percent private; 4 percent State; and 4 percent Tribal. Most federal lands in this unit (82 percent) are on national

forests managed by the USFS; with NPS (16 percent) and BLM (almost 2 percent) contributing most of the remainder. This unit includes most of Glacier National Park and parts of the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests, the BLM's Garnet Resource Area, and the Confederated Salish and Kootenai Tribes Flathead Reservation. It also includes (from northwest to southeast) all or parts of the Purcell, Cabinet, Salish, Whitefish, Lewis, Flathead, Swan, and Garnet mountain ranges. Several areas adjacent to this unit are known or thought to support a small number of resident lynx, at least intermittently, including the southern Selkirk Mountains of northern Idaho and northeastern Washington and the western Cabinet Mountains of northern Idaho (B. Holt 2016, pers. comm.; USFS 2015, pp. 9-10), and a small area of the Helena National Forest just south of MacDonald Pass, between Helena and Missoula (Gehman *et al.* 2011, p. 21). This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit may represent the southern extent of a larger cross-border population that also occurs in southwestern Alberta and southeastern British Columbia (B.C.). Relative to other DPS lynx populations, this unit is about 200 km (125 mi) east of the north-central Washington unit, about 145 km (90 mi) northwest of the GYA, and about 1,480 km (920 mi) west of the Northeastern Minnesota geographic unit.

Habitat Description: In the Northern Rocky Mountains, most lynx occurrences are associated with the Rocky Mountain Conifer Forest or Western Spruce-Fir Forest vegetative classes (Kuchler 1964, p. 4; McKelvey *et al.* 2000a, p. 246) at elevations ranging from 1,250 m (4,100 ft) to 2,500 m (8,200 ft) (Aubry *et al.* 2000, pp. 378–380; McKelvey *et al.* 2000a, pp. 243–245). The dominant vegetation that constitutes lynx habitat in these areas is subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanii*) and lodgepole pine (*Pinus contorta*) (Aubry *et al.* 2000, p. 379; Ruediger *et al.* 2000, pp. 4-8 - 4-10). Within these vegetation types, lynx appear to prefer areas of moderate to gentle topographic relief (Koehler and Aubry 1994, p. 86; Apps 2000, p. 352; Squires *et al.* 2013, pp. 187, 191). Lynx use large landscapes that include a temporally- and spatially-shifting mosaic of forest age classes, where natural or anthropogenic disturbances may reset forest succession (ILBT 2013, p. 28). Early successional stages that often provide dense horizontal cover at ground/snow level and support high hare densities (Griffin 2004, pp. 53-54, 70; Squires *et al.* 2010, pp. 1654-1656) may be created and maintained by natural disturbance processes including wildfire, insect infestations, tree diseases, and wind events (ILBT 2013, p. 28). Timber harvest, other silvicultural treatments, wildfire management, or other vegetation management, which may be beneficial, benign, or adverse to lynx and hare habitats depending on prescription, extent, and implementation, can also influence the amount and distribution of early successional stands (Agee 2000, p. 39; ILBT 2013, pp. 28, 71-76). Likewise, natural disturbance regimes and forest management can also influence the amount and distribution of mature multistoried spruce-fir stands, which can include dense horizontal structure, support high hare densities (Griffin 2004, pp. 53-54, 70; Squires and Ruggiero 2007, pp. 313-314; Berg *et al.* 2012, pp. 1483-1485), and provide preferred winter foraging habitat for lynx (Squires *et al.* 2010, pp. 1653-1657).

In northwestern Montana, lynx generally occur in mid-elevation (1,260 – 2,355 m [4,130 – 7,730 ft]) moist subalpine mixed-conifer forests dominated by Englemann spruce and subalpine fir and including Douglas fir (*Pseudotsuga menziesii*), western larch (Larix occidentalis), and lodgepole

pine (Squires *et al.* 2010, pp. 1653-1654). Lynx home ranges occur in areas with low surface roughness (i.e., low topographic relief; gently-sloping to moderately-steep terrain), high canopy cover indices, and little open grassland (Squires *et al.* 2013, p. 191). These lynx habitats occur below the alpine zone and above drier, more open forest types (e.g., ponderosa pine [*Pinus ponderosa*] and dry Douglas-fir/western larch/lodgepole pine) that do not provide lynx habitat (Agee 2000, p. 42; Berg 2009, p. 20; Squires *et al.* 2010, p. 1655). As elsewhere in the western portion of the DPS, this elevational pattern contributes, along with the transition from boreal to more temperate forests, to a naturally patchier, more fragmented distribution of lynx habitat than in the continuous boreal forest landscape in the core of the lynx's North American range in northern Canada and interior Alaska (65 FR 16052-53; 68 FR 40089; Squires *et al.* 2006[a], pp. 46-47; ILBT 2013, pp. 76-77; Squires *et al.* 2013, p. 191; 78 FR 59438). Squires *et al.* (2013, pp. 187-189) used telemetry data to model the distribution of probable lynx habitat in a 36,096-km^2 (13,937-mi^2) study area that completely overlaps this geographic unit. Their results indicate that much of the area has a low to moderate probability of selection by lynx, and that the areas with higher selection probabilities are relatively small and patchily- but widely- distributed throughout the unit and are separated by intervening areas of low probability of lynx use (Squires *et al.* 2013; see Figure 1(a), p. 189). This patchy distribution of high-quality habitats interspersed with areas of low-quality or non-habitat results in naturally lower densities of both snowshoe hares and lynx than those in the continuous boreal forests of northern Canada and Alaska (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373–375, 382, 394).

In winter in this unit, lynx preferentially use mature multistoried forest stands, predominantly spruce-fir, with dense horizontal cover, and they avoid clearcuts and large forest openings (Squires *et al.* 2010, pp. 1648, 1653–1656). In summer, lynx also select young stands with dense spruce-fir saplings, do not appear to avoid openings as in winter, and use slightly higher elevations (Ibid.). Both mature multistoried and young regenerating stands provide dense horizontal structure at ground/snow level, which supports higher snowshoe hare densities than more open young or mature forests. In the central (Seeley Lake study area) part of this unit, during an apparent regional hare decline in 1999-2001, summer hare densities were highest (up to 1.4 hares/ha in one study area) in dense young stands and winter densities were highest (up to 1.8 hares/ha in one study area) in dense mature stands (Griffin and Mills 2009, pp. 1492-1496). Over a longer interval (1999-2003) when hare populations in this area were thought to be stable (Squires and Ruggiero 2007, p. 314), mean summer and winter hare densities, respectively, were 0.34 hares/hectare (ha) and 0.53/ha in dense mature stands and 0.64/ha and 0.47/ha in dense young stands – habitats selected by lynx, compared to 0.18/ha and 0.20/ha in open mature stands and 0.18/ha and 0.12/ha in open young stands that lynx did not select (Squires and Ruggiero 2007, pp. 313-314). Even the relatively higher hare densities in the dense mature and dense young stands only marginally achieve the threshold density of 0.5/ha thought necessary to support lynx within home ranges (Ruggiero *et al.* 2000b, pp. 446–447; ILBT 2013, pp. 24, 26, 90). Nonetheless, hares accounted for 96 percent of the biomass in lynx diets in this unit based on evidence at kill sites (Squires and Ruggiero 2007, pp. 310-313), suggesting that even small declines in landscape-level hare densities could reduce the ability of habitats in this unit to support resident lynx (Squires *et al.* 2010, p. 1656).

Lynx in this unit generally den in mature spruce-fir forests among downed logs or root wads of wind-thrown trees in areas with abundant coarse woody debris and dense understories with high horizontal cover in the immediate areas around dens (Squires *et al.* 2004a, Table 3; Squires *et al.* 2008, pp. 1497, 1501–1505). Few dens are located in young regenerating or thinned stands with discontinuous canopies (Squires *et al.* 2008, p. 1497). Many dens have northeasterly aspects and are farther from forest edges than random expectation (Squires *et al.* 2008, p. 1497).

Average annual snowfall in this unit ranges from about 142 cm (56 in) in the Kalispell/ Whitefish/ West Glacier area of northwestern Montana to 183 cm (72 in) in Nordman in northern Idaho, to 216 cm (85 in) in Lincoln, Montana, near the southern end of the unit, to 259 cm (102 in) in Rexford, Montana near the Canada - U.S. border, to 345 cm (136 in) in Seeley Lake, Montana, in the central part of the unit, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 4/2/2016).

Habitat Status: Lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 84 percent (22,761 km^2 [8,788 mi^2]) of this unit is in federal ownership, including 18,695 km^2 (7,218 mi^2) in national forests under USFS management, 3,658 km^2 (1,412 mi^2) in Glacier National Park managed by NPS, and 397 km^2 (153 mi^2) managed by BLM in its Garnet Resource Area. As described above, potential lynx habitat in this unit is patchily- distributed and interspersed with areas of non-habitat (matrix). Among the six national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 54 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123). In Glacier National Park, 2,976 km^2 (1,149 mi^2; about 73 percent of the park) is considered “lynx forest types” (65 FR 16073), but only 1,103 km^2 (426 mi^2; 27 percent of the park, 37 percent of lynx forest types) is estimated to be lynx habitat (68 FR 40086, 40089). In the Garnet Resource Area, the BLM designated five LAUs (which approximate a lynx home range) covering 947 km^2 (366 mi^2), of which, 574 km^2 (222 mi^2; about 61 percent) was mapped as lynx habitat (Sparks 2016a, pers. comm.).

Federal lands are managed as either ‘‘developmental’’ or ‘‘nondevelopmental’’ land use allocations (68 FR 40093). Lands in developmental allocations are managed for multiple uses, such as recreation and timber harvest, some of which may conflict with lynx conservation. Management within non-developmental allocations focuses on the maintenance of natural ecological processes, or conservation of rare ecological settings or components, and these areas include wilderness, roadless, and semi-primitive non-motorized areas (USFWS 2007, pp. 33, 77). Timber harvest, road construction, and fire suppression typically do not occur or are very limited in lands managed in non-developmental allocations.

In this SSA unit, almost 46 percent of the federal land and 40 percent of the entire unit is in designated wilderness or national park land, including (in addition to Glacier National Park) the 6,297-km^2 (2,431-mi^2) Bob Marshall Wilderness Complex (Bob Marshall, Great Bear, and Scapegoat wilderness areas) on the Flathead, Lewis and Clark, Helena and Lolo national

forests, the 302-km^2 (117-mi^2) Mission Mountain Wilderness on the Flathead National Forest, the 139-km^2 (54-mi^2) Rattlesnake Wilderness Area on the Lolo National Forest, and the 371-km^2 (143-mi^2) Mission Mountain Tribal Wilderness on the Flathead Reservation. Management of NPS lands and both national forest and Tribal wilderness areas provides restrictions on land use beneficial to lynx (65 FR 16073; USFWS 2014, pp. 28-29; 79 FR 54831), and adverse effects of management activities on lynx habitats in these areas are unlikely. Among the six national forests that contribute to this unit, 56 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34).

Much of the remaining USFS lands and the BLM lands have developmental land-use allocations where some management activities have the potential to impact lynx or its habitat. However, as described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2004 amended the Resource Management Plan (RMP) for the Garnet Resource Area to incorporate the conservation measures identified in the LCAS (BLM 2004a, 2004b, entire; Sparks 2016b, pers. comm.). Both documents provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently- applied framework for conserving and restoring important hare and lynx habitats.

Habitat status on private lands, which account for about 8 percent of lands in this unit (2,172 km^2 [839 mi^2]), is governed by some federal and State regulations and buy a number of private-public conservations partnerships and State agency efforts. As described in section 3.1., above, some federal and State regulations guide some activities on private lands, including the ESA's prohibition on take of listed species, and State regulations governing trapping and timber management. In addition to these protections, there have been several other notable lynx conservation achievements on private lands in this unit since the DPS was listed. Two of these, the Clearwater-Blackfoot Project and the Montana Legacy Project, are multi-partner and community efforts led by The Nature Conservancy in Montana to purchase large tracts of private commercial timberlands, conveying some to the State of Montana and the USFS for conservation management, and acquiring conservation easements on others (TNC 2016a, 2016b, 2016c, entire). These land acquisitions have resulted in protection of roughly 673 km^2 (260 mi^2) of important lynx habitat within this SSA unit and another 583 km^2 (225 mi^2) just to the south and west that may occasionally or temporarily support lynx or provide dispersal habitat. Additionally, the MTFWP has acquired fee title or conservation agreements on 3,096 km^2 (1,195 mi^2) of private lands in western Montana, including 162 km^2 (63 mi^2) in designated lynx critical habitat in this SSA unit, with ongoing efforts on another 106 km^2 (41 mi^2) in the northwest part of the unit (MTFWP 2016, pp. 1, 3).

In addition to the MTFWP's efforts to acquire private lands and protect them through fee title or conservation agreement, the State of Montana has also worked to protect lynx habitat on State-owned lands, which account for about 4 percent of the lands in this unit (1,106 km^2 [427 mi^2]). As described above in section 3.1.2, the MTDNRC worked closely with the Service to develop the *State of Montana Department of Natural Resources and Conservation Forested State Trust Lands Habitat Conservation Plan* (MTDNRC HCP; MTDNRC and USFWS 2010a, 2010b, 2010c, entire); a multi-species HCP that focuses primarily on commercial forest management. The HCP includes a Lynx Conservation Strategy that minimizes impacts of forest management activities on lynx, describes conservation commitments that are based on recent information from lynx research in Montana, and commits to active lynx monitoring and adaptive management programs. The HCP covers about 2,220 km^2 (857 mi^2) of forested State trust lands in western Montana, including 703 km^2 (271 mi^2) within this SSA geographic unit (about 64 percent of State lands in this unit). The goal of the HCP's Lynx Conservation Strategy is to support federal lynx conservation efforts by managing for habitat elements important to lynx and their prey that contribute to the landscape-scale occurrence of lynx. Specific objectives to achieve this goal include protecting den sites and potential denning habitat, mapping and maintaining lynx foraging habitats and limiting the spatial and temporal scope of their conversion to unsuitable conditions from forest management activities, and providing for habitat connectivity (MTDNRC and USFWS 2010b, pp. 2-45 - 2-61). The HCP was finalized and permitted by the Service in 2011, and includes a 50-year commitment by the State to manage for lynx conservation on these lands (79 FR 54835-37).

Tribal lands of the Flathead Reservation account for almost 4 percent of this unit. In addition to the Tribe's approach to lynx management described in section 3.2.1, above, most lynx and lynx habitat on the reservation occur in areas with formal protective status, including: (1) The long-designated Mission Mountains and Rattlesnake Tribal Wilderness Areas, which are largely roadless and managed for wilderness qualities; (2) the South Fork/Jocko Primitive Area, which is open to use only by Tribe members and in which commercial timber harvest is prohibited; and (3) the Nine-mile Divide country, which is marginal in terms of lynx habitat, but which is also partly roadless (Courville 2014, pers. comm.; 79 FR 54831).

As elsewhere in the DPS, winter foraging habitat is thought to be the most limiting habitat for lynx in this unit (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27). As described above, lynx selected mature multistoried stands with dense horizontal structure and relatively higher winter hare densities (Squires *et al.* 2010, pp. 1648, 1653–1656). Because of this preference, the Forest Service in the NRLMD adopted a vegetation management standard (VEG S6) that precludes all vegetation management activities that could reduce winter snowshoe hare habitat in multistoried forests, not just precommercial thinning as recommended in the LCAS (USFS 2007, pp. 13-14). Also as elsewhere (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517, ILBT 2013, p. 30; 79 FR 54790), denning habitat is not thought to be a limiting factor for lynx in this unit (Squires *et al.* 2008, p. 1505). Nonetheless, the NRLMD includes guidance to ensure adequate denning habitat remains well distributed in LAUs and, therefore, across the larger landscape and to design projects to create or retain coarse woody debris in areas where denning habitat may be lacking (USFS 2007, p. 17). Snow conditions in this unit

also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America, showing that this geographic unit has a 90-95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

Overall, although naturally fragmented and patchily-distributed, lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway) development and evidence of minor genetic differentiation among lynx subpopulations (see *Lynx Status*, below), past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

A possible exception may be in the Garnet Mountains, which are known to have supported a small number of resident lynx in the 1980s and recently from 2002-2010, but where more recent surveys and research trapping efforts have failed to detect lynx (Squires *in* Lynx SSA Team 2016, p. 20; also see Lynx Status, below). This small and relatively isolated island of lynx habitat (Squires 2014, p. 4) at the southern end of this unit is thought to be capable of supporting 7-10 lynx home ranges (Squires 2016, pers. comm.). The BLM (2004, pp. 4-5) contrasted current and historical distributions of lynx habitats in the Garnets and found that early- successional stands (future hare and lynx foraging habitats) were at 25-50 percent of the historic condition in lower- elevation (1,370-1,830 m [4,500-6,000 ft]) lynx habitats, and 10-30 percent in higher- elevation (1,675-2,130 m [5,500-7,000 ft]) habitats. Late- successional (mature multistoried) stands (25-75 percent of historical condition) and large (> 100 ha [250 ac]) patches (25-50 percent of historical condition) were also underrepresented at lower elevations, but at higher elevations, late- successional stands and large patches exceeded 200 percent and 100 percent of historical conditions, respectively. Lower elevation habitats were fragmented by roads and past management practices (i.e., timber harvest), while higher-elevation habitat patterns were attributed to the absence of disturbance, including fire (BLM 2004, p. 5), though fire absence was not attributed to suppression.

As discussed for the GYA in section 2.3.2.2, above, whether the recent absence of lynx in the Garnets represents the extirpation of a previously- persistent small resident population (and, therefore, a contraction in the range of resident lynx in this unit) or a temporary “winking off” of a small peripheral population that would be expected in a mainland-island metapopulation structure is uncertain and perhaps irresolvable. If residency was intermittent historically, the current absence of lynx might be a natural condition related to the area’s naturally fragmented habitats and generally low hare densities - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. If so, future intermittent lynx occupancy would be expected, but only if lynx dispersing from a source

population immigrate to the Garnets when habitat conditions and hare densities return to more favorable levels. Conversely, if the Garnets historically supported a small but persistent population that was recently extirpated, it may suggest that the alteration of the historic distribution of some habitats in some parts of the range, described above, was enough to tip the quality of the area's habitat from capable of supporting a small resident population to no longer capable of doing so.

In summary, almost all lands in this unit are managed to conserve lynx and hare habitats in accordance with federal, State, and Tribal regulations and management direction, conservation easements, and an approved HCP. Much of the area consists of designated federal and Tribal wilderness areas and other nondevelopmental land use allocations, where management activities with the potential to adversely affect lynx generally do not occur. On lands with development allocations, USFS, BLM, and State management are based on plans that incorporate the conservation guidance identified in the LCAS as informed by more recently-available scientific information. The State and TNC, working with other conservation partners, have bought or acquired conservation easements on large tracts of high-quality private lands in the unit that are known or suspected to be occupied by resident lynx. These efforts and management across multiple ownerships likely preclude landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places, as described above for the Garnet Mountains. Because lynx habitats in this unit, like most other areas of the DPS range, are naturally highly-fragmented, and most have hare densities that barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit although, as described in section 2.3.2.2 above, it is thought to be capable of supporting perhaps 200-300 lynx (Squires *in* Lynx SSA Team 2016, p. 41). This is substantially fewer than previous estimates of more than 1,000 lynx, which were based on a habitat area/ density index and broad assumptions regarding habitat suitability and lynx distribution (65 FR 16058) that are not supported by current understanding of lynx habitat requirements. As described above, habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Although the exact distribution of resident lynx remains uncertain, this unit has a long and continuous history of lynx occurrence and evidence of reproduction (McKelvey *et al.* 2000, pp. 224-225; Squires and Laurion 2000, pp. 346-348; Squires *et al.* 2008, entire; Squires *et al.* 2013, entire; ILBT 2013, p. 57; 65 FR 16058; 68 FR 40090; 74 FR 8643; 79 FR 54825). Genetic analyses revealed minor fine-scale genetic sub-structuring among lynx subpopulations in the southern (Garnets), central (Seeley Lake), and northern (Purcells) parts of this unit, suggesting limited interaction among lynx in those areas (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5; Squires *in* Lynx SSA Team 2016, p.

20). Lynx in this unit likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia, but the extent to which lynx persistence in this area may rely on immigration from Canada is unknown, and there is no indication of substantial immigration (irruptions) of lynx from Canada into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20).

From 1998 to 2007, researchers with the Forest Service's Rocky Mountain Research Station in Missoula trapped and radio-marked 175 lynx in northwestern Montana and collected nearly 170,000 GPS and over 3,000 VHS telemetry locations documenting lynx movements, resource use, survival, and productivity (Squires *in* Lynx SSA Team 2016, p. 20). From 1999-2007, litter sizes averaged 2.24 kittens/litter (N = 33) in the Seeley Lake area and from 2003-2007, 2.95 kittens/litter (N = 22) in the Purcell Mountains. In Seeley Lake, 61 percent of breeding-age females (N = 52) produced kittens; in the Purcells, 83 percent of females (N = 28) produced kittens. Recent research (Kosterman 2014, entire) suggests that the probability that a female produces a litter and initial litter size are correlated positively with mature forest connectivity and negatively with fragmentation in female home ranges (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix A). Annual survival rates for subadult and adult female lynx were 0.52 and 0.75, respectively, in Seeley Lake, and 0.68 and 0.85, respectively, in the Purcells. There was no evidence of cyclicity in these vital rates, and no indication of substantial immigration of lynx into these study areas from Canada. Starvation, predation by mountain lions, and human-caused deaths each accounted for roughly one-third of documented sources of lynx mortality. Population viability analyses yielded population growth rates (λ) of 0.92 for the Seeley Lake area (i.e., declining population trend, 1999-2007) and 1.16 for the Purcells (increasing trend, 2003-2007). However, as described in section 2.2.2, above, estimates of λ in a cyclic Canadian population of lynx ranged from 2.03 (annual doubling) when hares were abundant to 0.10 (order of magnitude decline) after hare populations crashed (Slough and Mowat 1996, p. 952, Table 4), and the natural range in λ that would be expected among peripheral, isolated, or semi-isolated and non-cyclic or weakly-cyclic lynx populations in the DPS versus those that would signal long-term population decline or instability is unknown.

As described above, lynx distribution in this unit may have contracted with the recent apparent disappearance of resident lynx from the Garnet Mountains in the southern part of the unit. Lynx were documented in the Garnets in the 1980s and from 2002-2010, but no lynx were detected during snow-track and camera-trap surveys in winter 2014-2015 (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix 5). This area is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.); 5 lynx were monitored via telemetry in 2002, 3 in 2003-2004, 2 in 2005, and single lynx each year in 2006, 2007, and 2010 (Squires *in* Lynx SSA 2016, Appendix 5 [2015 10 14 - 8, p. 26]). As described in section 2.3.2.2 and above, whether the recent absence of lynx from this part of the unit represents the extirpation of a small but previously persistent population (and, therefore, a permanent contraction of lynx distribution in this unit) or the temporary "winking off" of a peripheral subpopulation that may become "winked on" again in the future is unknown and perhaps irresolvable.

Snow-tracking, hair-snare, and camera-trap surveys in other parts of this unit since the DPS was listed continued to detect lynx on the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests (USFS 2015, pp. 9-27). On the Flathead, the USFS Rocky Mountain Research Station(RMRS) trapped and radio-marked 7 lynx (3 females, 4 males) in the Flathead River watershed from 2010-2015, and surveys detected lynx in several other areas including the Salish Mountains, the area just south of Glacier National Park, and in the vicinity of Hungry Horse Reservoir (USFS 2015, pp. 10-11). The Swan Lake District in the southern part of the Flathead, along with the Seeley Lake District of the Lolo National Forest and the Lincoln District of the Helena National Forest, is part of the 6,070-km^2 (2,344-mi^2) Southwestern Crown of the Continent, which was intensively surveyed from 2012-2014 by the Southwestern Crown Carnivore Monitoring Team (SCCMT 2014, entire). The SCCMT conducted snow track surveys and used hair snares, bait stations, and camera traps to detect lynx in 36 of the 82, 8 x 8 km (5 x 5 mi) grid cells they surveyed (SCCMT 2014, pp. 3, 17-20). The surveys resulted in collection of DNA that allowed identification of 18 individual lynx (5 females, 13 males), 13 of which were new to regional lynx databases (SCCMT 2014, pp. 3, 17-20).

On the Helena National Forest, few lynx have been detected outside the Lincoln District/ Southwest Crown described above. In the south MacDonald Pass area, just south of this SSA unit and south of designated critical habitat, an individual male lynx was verified by DNA evidence over four winters (2007-2011), and an individual female was verified in the same area in the winter of 2008-2009 (Gehman *et al.* 2011, p. 21; USFS 2015, p. 27). Other surveys on the Helena failed to detect lynx in the disjunct Big Belt and Elkhorn Mountains, although telemetry data indicated that three lynx released in Colorado passed through the Big Belts in 2004-2006 (USFS 2015, pp. 26-27). Likewise, during snow tracking surveys on the Lolo in 2010-2011 (prior to the Southwestern Crown monitoring described above), lynx were also confirmed on the Seeley Lake District in the eastern part of the forest, but no lynx were documented on the Missoula or Ninemile districts, nor on the Superior and Plains/Thompson Falls districts in the western part of the forest (USFS 2015, pp. 12-14). The USFS concluded that lynx presence in districts other than Seeley Lake is extremely rare and likely represents occasional dispersing lynx (USFS 2015, p. 21).

On the Kootenai National Forest, RMRS research efforts continued to document the long-term presence of lynx, where trapping and radio-marking efforts yielded 50,000-60,000 lynx telemetry locations from 2003-2012 (USFS 2015, p. 10). On the Lewis and Clark National Forest, lynx are considered “still present” in the Rocky Mountain Front portion of the forest, which is within this geographic unit and designated critical habitat, and snow track surveys from 2010-2013 in the disjunct Little Belt and Crazy Mountains documented the continued absence of resident lynx in those ranges (USFS 2015, pp. 25, 27-34). On the Idaho Panhandle National Forest, surveys detected individual lynx in the Selkirk Mountains in 2010 and 2011 and in the Purcell Mountains in 2012. All detections were within 15 miles of the Canada-U.S. border (USFS 2015, p. 10). No lynx were detected during surveys in 2007 or 2013-2014, and snow surveys were not done in 2015 because of poor snow conditions (USFS 2015, p. 9). However, in 2012-2014 three lynx were incidentally trapped on the Idaho Panhandle (one in 2012 in the Purcells, and two in 2014

in the Cabinet Mountains), and another was documented by a Service grizzly bear trapping crew in the Purcells in 2014 (USFS 2015, pp. 9-10; U.S. District Court ID 2016, pp. 6-7).

In summary, although the number of lynx in this geographic unit is uncertain, resident lynx appear to remain broadly distributed throughout most of the unit. The recent apparent absence of lynx in Garnet Mountains may indicate extirpation of a small resident population and a contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure. Lynx are rarely detected on surveys on other national forests (or parts of those above) that are outside but adjacent to this geographic unit (Patton 2006, entire; USFS 2105, pp. 1-9, 25-34), suggesting that these areas lack the habitat features and/or landscape-level hare densities necessary to support resident lynx populations (79 FR 54818-54820).

Factors Affecting Current Conditions: *Regulatory Mechanisms* - Federal management activities (especially timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. For example, as described above in *Habitat Status* and *Lynx Status*, past timber harvest/management and associated road construction may have fragmented, reduced the amount, and altered the distribution of lynx habitats in the Garnet Mountains, perhaps contributing to the apparent recent loss of that area's ability to support resident lynx.

Currently, as described above and in section 3.1, all federal and Tribal lands, most State lands, and large blocks of private or formerly-private land in this unit are managed for the conservation of lynx habitats, and much of the unit is in designated wilderness or other nondevelopmental land-use allocations. Regulatory mechanisms and conservation measures associated with these management strategies are intended to conserve and restore lynx and hare habitats across large landscapes and multiple ownerships. Although their effectiveness has not be quantitatively evaluated, and despite the potential extirpation of a small population in the Garnets, lynx habitats and resident lynx appear to remain well distributed throughout most of this unit.

Other regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, 16 lynx are documented to have been incidentally trapped in Montana, with 13 of those occurring before 2008, when more protective regulations were put in place (MTFWP 2016, pp. 5-10). Of the 16, eight were released uninjured, one was released with an injury, and seven were killed; all incidences of mortality occurred prior to 2008 and the implementation of the more protective regulations (MTFWP 2016, p. 5). In Idaho, in addition to the three lynx incidentally trapped on the Idaho Panhandle National Forest from 2012-2014 (described above under *Lynx*

Status), one other lynx was incidentally trapped in 2012 on the Salmon-Challis National Forest further south (U.S. District Court ID 2016, p. 6).

Although lynx are legally trapped in Canada adjacent to this unit in southern Alberta and southern British Columbia, trapping there is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Environment Canada 2014, entire; Vashon 2015, pp. 5-6). Lynx harvest in Alberta varied from about 4,000 to 14,000 annually in the late 1970s and early 1980s, but declined to fewer than 2,000 for most years from 1984-2000, and restrictive quotas and season closures were implemented beginning in the late 1980s (Poole and Mowat 2001, pp. 16, 28). Similarly, harvests in British Columbia peaked at over 12,000 in the early 1960s and over 8,000 in the early 1970s, then declined to fewer than 2,000 for most years from the mid-1980s until the year 2000 (Hatler and Beal 2003, p. 2). Whether, and if so to what extent, trapping in Canada may influence lynx dispersal across the border and into this geographic unit is unknown; however, such dispersal was documented historically when harvest levels in Canada were much higher than under current management.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Hall and Fagre 2003, entire; Mote 2003, entire; Fagre 2005, entire; Knowles *et al.* 2006, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Squires *in* Lynx SSA 2016, p. 20; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities, even in areas considered high-quality habitat for this DSP unit, often appear to barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 90-95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et*

al. 2010. pp. 607, 609). Although insect outbreaks have affected some parts of the DPS, no major outbreaks have been documented in lynx habitats in this unit (Lynx SSA Team 2016, p. 41).

Vegetation Management - As elsewhere in the DPS range, timber harvest and related vegetation management (precommercial thinning and other silvicultural techniques designed to optimize forest products outputs; ILBT 2013, pp. 71-72) are the dominant land uses potentially affecting lynx habitats in this unit (68 FR 40075, 40092; 79 FR 54825). As described in section 3.3, above, these activities can reduce hare and lynx habitats by reducing horizontal cover and altering natural disturbance regimes and forest successional patterns. In this unit, precommercial thinning was shown to reduce short-term hare abundance (Griffin and Mills 2007, entire) and appeared to influence lynx movements (Squires *et al.* 2013, p. 192-194), and lynx rarely traveled across recent clearcuts or other large openings, especially in winter (Squires *et al.* 2010, p. 1654; ILBT 2013, p. 77). However, as described under *Habitat Status*, above, these activities on federal lands, which account for most of the lands in this unit, occur only on lands with developmental allocations and historically appear to have impacted only a small proportion of potential lynx habitats in this unit (65 FR 16072; 68 FR 40093). Additionally, timber harvest levels on federal lands in the West, including the Northern Rockies, and specifically with regard to “lynx forest types,” had declined consistently and dramatically for a decade or longer prior to the DPS being listed (68 FR 40093), and have remained at levels much lower than those from most of the previous century. Despite some likely localized impacts, past vegetation management does not appear to have broadly diminished this unit's ability to support resident lynx, although, as described above, it may have contributed to the current absence of a small number of resident lynx from the Garnet Mountains. Also as described above, current vegetation management in this unit on all federal, most State and Tribal, and some private lands, is conducted in accordance with formally amended USFS and BLM management plans, an approved State HCP, Tribal regulations, and conservation easements designed to avoid or minimize impacts to lynx habitats, especially important hare and lynx winter foraging habitats.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, where about 15 percent (4,172 km^2 [1,611 mi^2]) of the unit has burned from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20), likely in response to climate warming and related increases in drought conditions (e.g., Harvey *et al.* 2016, entire; Westerling 2016, entire). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit’s ability to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction. In the Northern Rocky Mountains, the forests upon which lynx depend have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and

these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx (with the possible exception of the Garnet Mountains). Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Idaho (1) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. This unit is directly connected to lynx habitats and populations in southwestern Alberta and southeastern British Columbia, where lynx habitats are also (like Montana and Idaho) patchily-distributed and generally support low hare densities, and where some lynx populations may be ephemeral and the persistence of others reliant on periodic influx of immigrants (Apps 2007, pp. 81, 95-104). Additionally, connectivity between this geographic unit and lynx habitats and populations in southern Alberta and southern British Columbia may be facilitated by only a few predicted corridors that extend south from the international border (Squires *et al.* 2013, pp. 187, 191-193).

Although lynx occurrence and harvest records in this geographic unit reflect the unprecedented irruptions of lynx from Canada into the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 224-226, 232-242), there is no evidence of irruptions of lynx into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). This is supported by lynx trapping records from Canada, which suggest that the magnitude of lynx populations cycles in Alberta and British Columbia dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Poole and Mowat 2001, p. 28; hatler and Beal 2003, p. 2; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which would be expected to alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a

gradual decline of a resident lynx population that needs but is not receiving adequate immigration. In contrast, the growth rate estimated for the lynx population in the Purcell Mountains in the northwestern part of this unit (λ = 1.16, increasing trend 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) suggests that the level of immigration, if necessary for demographic stability, has been adequate or that productivity and recruitment have been high enough to offset potentially diminished immigration. It is also possible that, despite the documented historical intermittent (cyclic) influxes of lynx from Canada into lynx populations in this geographic unit, immigration does not contribute meaningfully to the demographic stability of these populations. If that is the case, the estimated growth rates suggest that recruitment has failed to offset mortality in the Seeley Lake population but that it has more than done so in the Purcell Mountains population.

4.2.4 Unit 4 - North-central Washington

Unit Description: This geographic unit is located in the northern Cascade Mountain Range of north-central Washington in portions of Chelan and Okanogan Counties and includes mostly Okanogan-Wenatchee National Forest lands as well as BLM lands in the Spokane District that were designated as critical habitat (Unit 4) for lynx in 2014 (79 FR 54825). The unit also includes State Forest lands (portion of the Loomis State Forest) that were excluded from designation as critical habitat (79 FR 54825). It encompasses approximately 5,176 km^2 (1,988 mi^2), with ownership that is 91.5 percent federal (USFS, BLM), 8.2 percent State, and 0.3 percent private lands; there are no Tribal lands. This area was occupied at the time lynx was listed and is currently occupied by the species. Evidence from recent research and DNA analysis shows lynx distributed within this unit, with breeding being documented. Although researchers have fewer records in the portion of the unit south of Highway 20, this area contains boreal forest habitat and the components essential to the conservation of the lynx. Further, it is contiguous with lynx habitat north of Highway 20, particularly in winter when deep snows close Highway 20. The northern portion of the unit adjacent to the Canada border also appears to support few recent lynx records; however, it is designated wilderness, so access to survey this area is difficult. This northern portion contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia directly north of this unit.

As it is throughout the range of lynx in the contiguous U.S., maintaining connectivity with Canada is important to lynx populations in northern Washington and the Cascade Mountains. Singleton *et al.* (2002, entire) evaluated landscape permeability for large carnivores in Washington. They reported broad landscape permeability for lynx between the Thompson River watershed in British Columbia and the U.S. portion of the northern Cascades (Singleton *et al.* 2002, p. 46). According to the LCAS, connectivity currently appears functional, as lynx dispersal from Washington into Canada was recently documented. A male lynx radio-collared in 2008 in the Loomis State Forest remained there until late winter in 2009, when it dispersed north into Canada toward Hope, British Columbia, and then headed north-east toward Kamloops where it appeared to establish a home range just southeast of Kamloops. This individual was later

trapped and killed in British Columbia, highlighting the need for cooperation and shared management goals across political boundaries (LCAS 2013, p. 65).

Several areas adjacent to this geographic unit (e.g., Kettle Range, the Wedge, Little Pend Oreille, Selkirk Mountains of northeast Washington) are known or thought to support a small number of lynx, at least intermittently. One of these areas in particular (Kettle Range) contains the second largest block of potential lynx habitat in Washington comprising approximately 987 km^2 (381 mi^2), which is significantly smaller than the North Cascades that supports approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (Stinson 2001, p. 18). Historically, although the Kettle Range supports a fairly small block of lynx habitat (relative to other geographic areas supporting persistent lynx populations), it was considered to be a stronghold for lynx in Washington (Stinson 2001, p. 14). The Kettle Range was suspected to have supported a resident population until about 30 years ago when over-trapping may have resulted in their extirpation from the mountain range (Koehler *et al.* 2008, p.1523). For example, lynx were consistently trapped in the Kettle Range in the 1960s, 1970s, and 1980s. In the Kettle Range, a total of 81 lynx were trapped from 1961 through 1986. One lynx was harvested in 1963, 3 in 1966, 7 in 1967, 2 in 1969, 26 in 1970, 14 in 1976, and 17 in 1977. A single lynx was taken each year in 1980, 1983, 1985, and 1986 (Stinson 2001, p. 63). Prior to 1961, lynx trapping records were not maintained in Washington. Beginning in 1978, trapping seasons in Washington for lynx were reduced to one month. In 1987 a restricted permit system was implemented, and in 1990 a statewide closure on lynx trapping was implemented (Service 2008).

Lynx habitat in the Kettle Range is limited in size and capable of supporting few lynx. According to Koehler *et al.* (2008, p. 1523), the Kettle Range could support between 10 to 23 lynx based upon a lynx density of 2.3 lynx/100km^2 and 400 km^2 (154 mi^2) to 987 km^2 (381 mi^2) of lynx habitat. It should be noted that the lynx density estimate was derived from research conducted in the Cascade Range within a large area of contiguous, high quality habitat (Koehler 1990, pp. 845, 847). Lynx habitat in the Kettle Range is much smaller and likely more fragmented, and thus may not be capable of supporting a density of 2.3 lynx/100 km^2. The Kettle Range is also somewhat isolated from other lynx habitats in Washington (e.g., the Cascades) and British Columbia. The Kettle Range is separated from the Cascades in Washington by low elevation valleys dominated by shrub-steppe and Douglas-fir and ponderosa pine forests (Koehler *et al.* 2008, p. 1523), and from British Columbia by the Kettle River Valley (Stinson 2001, p. 20) and a major highway corridor with associated fence in British Columbia (Koehler *et al.* 2008, p. 1523). These natural topographic and anthropogenic features may present impediments to lynx movement between the Kettle Range and the Cascades and British Columbia, making natural recolonization of the Kettle Range by lynx difficult. Thus, it may be difficult for lynx to reestablish a persistent and viable resident breeding population in the Kettle Range.

Habitat Description: In the northern Cascades most lynx occurrences are associated with the Rocky Mountain Conifer Forest (Aubry *et al.* 2000, p. 379; McKelvey *et al.* 2000, p. 246) at elevations between 1,400 m (4,593 ft) and 2,150 m (7,053 ft) (McKelvey *et al.* 2000, p. 322; Stinson 2001, p. 9). Within this area lynx primarily use forests dominated by Engelmann spruce,

subalpine fir, or lodgepole pine on mild to moderate slopes (less than 30 degrees), and avoid Douglas-fir and ponderosa pine forests, forest openings, recently burned areas with sparse canopy and understory cover (less than 10 percent), low elevations [less than 915 m (3,000 ft)], and steep slopes (greater than 30 degrees) (Koehler *et al.* 2008, pp. 1518, 1521; Maletzke 2004, pp. 16-17). Similar to the northern Rocky Mountains, lynx habitat in the Cascades is naturally fragmented (Koehler *et al.* 2008, p. 1523). Disturbance is common in boreal forests, and fires and insect epidemics are major drivers of this disturbance, but other factors including wind and disease also contribute to the process of disturbance (Agee 2000, p. 47). Fire return intervals in the north Cascades ranges between approximately 100 to 250 years (Agee 2000, p. 50).

Snowshoe hares are the primary prey of lynx throughout their range in North America (Mowat *et al.* 2000, p. 267) comprising 35-97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Lynx also consume other prey species, including red squirrels, mice, voles, grouse, ptarmigan, and other species of mammals and birds, especially during summer or when snowshoe hare population densities decline (Mowat *et al.* 2000, pp. 267-268). Koehler (1990, p. 848) found snowshoe hares were the primary prey of lynx in the north Cascades of Washington occurring in 23 of 29 (79 percent) lynx scats examined, but the remains of red squirrels were identified in 7 of the 29 (24 percent) lynx scats, as were the remains of other species including deer and mice. Von Kienast (2003, p. 39), who also conducted a lynx study in the north Cascades of Washington, found snowshoe hares in 87% (40 of 46) of lynx scats, while red squirrels were identified in 28% (13 of 46) of lynx scats.

Results of lynx research in the northern portion of its range suggest that a minimum density of 0.5-1.0 hares/ha (0.2-0.4 hares/ac) is needed to support lynx reproduction, but it is unknown if a similar snowshoe hare density is required to support lynx reproduction in the southern portion of its range (Ruggiero *et al.* 2000b, p. 446). In the northern portion of lynx range (i.e., the taiga) peak snowshoe hare densities regularly exceed 4-6 hares/ha (1.6-2.4 hares/ac), and cycle as low as 0.1-1 hares/ha (0.04-0.4 hares/ac) (Hodges 2000, pp. 119-120). In the southern portion of lynx range (e.g., the U.S.) snowshoe hare densities are low compared to those in northern regions (Aubry *et al.* 2000, p. 375). Walker (2005, p. 20) estimated an average snowshoe hare density of 0.89 hares/ha (0.36 hares/ac) with a range of 0.03 to 4.85 hares/ha (0.01 to 1.94 hares/ac) in north central Washington (i.e., the Cascades). The Washington Department of Natural Resources (WADNR) found snowshoe hare densities between 0.3 and 0.7 hares/ha (0.1 and 0.3 hares/ac) on the Loomis State Forest (WADNR 2006, p. 87).

Lynx distribution is nearly coincident with the distribution of snowshoe hares (McCord and Cardoza 1982, entire; Bittner and Rongstad 1982, entire), and lynx occupy habitats where snowshoe hares are abundant (Koehler and Aubry 1994, p. 84). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448). Average annual snowfall is consistent throughout this unit and is approximately 291 cm (114.5 in) (https://snowfall.weatherdb.com/d/a/Washington; accessed 4/27/2016).

Habitat Status: The range of lynx in the contiguous U.S. is broadly delineated by the distribution of the southern extensions of boreal forest. However, the complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with naturally dynamic habitat, make it difficult to precisely delineate the historic range of lynx in the U.S. (68 FR 40084). McKelvey *et al.* (2000, pp. 245-246) described the historic range of lynx in the western U.S., encompassing at least 75 percent of lynx occurrences, as associated with the Rocky Mountain Conifer Forest containing the primary vegetation types of Douglas-fir and western spruce/fir forests. These western spruce fir forests represent the southern extension of boreal forests into the U.S. (Agee 2000, pp. 40-42, 46). The amount of boreal forest habitat in the contiguous U.S. has not changed substantially in the past 100 years (68 FR 40085).

However, while the boreal forest may not have changed substantially within the past 100 years (i.e., permanent or long-term reductions in the quantity or size), it is naturally dynamic with fire and insects representing major disturbance processes (Agee 2000, p. 47) that can create areas temporarily unsuitable for lynx through regeneration of forested stands to early successional conditions (Agee 2000, pp. 62-63). In 2001, the Washington Department of Fish and Wildlife (WDFW) estimated there was approximately 8,923 km^2 (3,445 mi^2) of potential lynx habitat within this geographic unit. Several wildfires affected lynx habitat in the north Cascades during the middle 1990s and early 2000s: 1994 Whiteface Burn (1,554 ha (3,840 ac)); 1994 Thunder Mountain Fire (3,686 ha (9,108 ac)); 2001 Thirty-Mile Fire (2,565 ha (6,338 ha)); and 2001 Farewell Fire (32,278 ha (79760 ac)) (Vanbianchi 2015, p. 23). Subsequent to these fires and incorporating new science on lynx habitat use, Koehler *et al.* (2008, pp. 1521-1522) estimated this geographic unit contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on studies conducted from 2002 through 2004. More recent wildfires, including the 2006 Tripod Fire (70,644 ha (175,656 ac)) (Vanbianchi 2015, p.23), have affected approximately 1,000 km^2 (386 mi^2) of lynx habitat within this geographic unit (Lynx SSA Team 2016, p. 21). Cumulatively, over the past 2 decades these wildfires have burned greater than 50 percent of the suitable lynx habitat within this geographic unit (Koehler *et al.* 2008, p. 1523). These acres are expected to regenerate back into suitable lynx habitat, but it may take several decades for this to occur.

Lynx Status: In Washington, there is little information on the status of the lynx population prior to the early 1960s (Stinson 2001, p. 13). From 1960-61 to 1990-91 a total of 234 lynx were harvested in Washington, with the most lynx trapped in Ferry County (35 percent of the 234), followed by Okanogan (23 percent) and Stevens (10 percent) counties (Stinson 2001, p. 13). The WDFW identified six lynx management zones (LMZs) in Washington: Okanogan, Vulcan-Tunk, Kettle Range, The Wedge, Little Pend Oreille, and Salmo-Priest (i.e., essentially the Selkirk Mountain Range in northeast Washington (Stinson 2001, p 14). In 2001, the WDFW considered lynx to be present in the Okanogan, Kettle Range, Little Pend Oreille, and Salmon-Priest LMZs; at that time lynx had not been detected in the Wedge LMZ since 1987 nor the Vulcan-Tunk LMZ since 1990 (Stinson 2001, p.15).

In 2001, based on data collected from lynx telemetry studies conducted in the Cascade Range during the 1980's, the WDFW estimated that Washington contained approximately 12,579 km^2 (4,857 mi^2) of lynx habitat which could theoretically support up to 238 lynx (based on a lynx

density of 2.5 lynx/100 km^2) (Koehler 2008, p. 1518; Stinson 2001, p. 16). However, based on professional opinions of individuals knowledgeable about lynx and lynx habitat, the WDFW adjusted this number down suggesting that Washington likely supported fewer than 100 individual lynx (Stinson 2001, p. 16). More recently, Koehler *et al.* (2008, p. 1523), estimated there was approximately 3,800 km^2 (1,467 mi^2) of lynx habitat in Washington potentially supporting up to 87 lynx. This more recent population estimate was based on a study investigating lynx habitat use in the Okanogan from 2002 to 2004, and used a lynx density estimate of 2.3 lynx/100 km^2 derived from a radio-telemetry study conducted on lynx in the Cascades from 1985-1987 (Koehler 1990, pp. 845-847). However, the study area in which the 2.3 lynx/100 km^2 density estimate reported by Koehler (1990, p.847) was derived is located in an area of the northern Cascades known as the "Meadows". During the time of Koehler's (1990, entire) study the Meadows provided some of the best lynx habitat in Washington, whereas most other lynx habitat in Washington is lower in elevation and more highly fragmented (Walker 2005, pp. 3, 6). Thus, the lynx densities Koehler observed in his study area in the Meadows may not translate to lynx densities throughout the rest of lynx habitat in Washington, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines. Thus, applying Koehler's estimated lynx density uniformly throughout Washington, may overestimate the overall lynx population capable of being supported in Washington.

Relative to the Okanogan LMZ (i.e., the north Cascades), which supports the only known persistent breeding population of lynx in Washington State, in 2001, the WDFW estimated the LMZ could support a maximum of 149 lynx (Stinson 2001, p. 16). This number was derived by estimating that the LMZ contains approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (which was decreased by 33 percent to account for unsuitable areas) combined with an average lynx population density estimate of 2.5 lynx/100km^2 derived from two studies conducted in the 1980s (Stinson 2001, p. 16). The estimated quantity of lynx habitat was based on mapping areas supporting the forest-type and physiographic characteristics identified as being used by lynx during telemetry studies conducted in the 1980s (Koehler *et al.* 2008, p. 1518), irrespective of the current condition (successional stage, or stand type, structure, or age, etc.) of the habitat. The estimation of lynx habitat was based purely on forested areas potentially supporting a forest-type potential of subalpine fir/Engelmann spruce, and the physiographic characteristics of elevations greater than 1,400 m (4593 ft) on mild to moderate slopes (Koehler *et al.* 2008, p. 1518), and did not consider whether the area was recently burned, harvested, etc. Recognizing that new information on lynx and snowshoe hare habitat use patterns had been learned since the 1980's, and that several large, stand-replacing fires had burned in lynx habitat, Koehler *et al.* (2008, entire) conducted a lynx telemetry study in the Okanogan from 2002 to 2004 to reassess the suitability of lynx habitat. They estimated that the Cascades contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on mapping areas supporting Engelmann spruce/subalpine fir forests with moderate canopy cover on flat to moderate slopes at elevations from 1,525 m (5003 ft) to 1,829 m (6000 ft) (Koehler *et al.* 2008, pp. 1521-1522). Therefore, at that time and using Koehler's (1990, p. 847) lynx density estimate of 2.3 lynx/100 km^2, the Cascades could theoretically support approximately 55 individual lynx.

From 1985 to 1987, the movements of five adult male and two adult female radio-collared lynx were monitored by Koehler (1990, entire) in the Cascades of north-central Washington. During the study two kittens were also captured and ear-tagged (Koehler 1990, p. 847). Results of the study indicated female average home range size was 39 km^2 (15 mi^2) and average male home range size was 69 km^2 (27 mi^2). Based on occupancy of the 640 km^2 study area by 15 adult lynx, adult lynx density was estimated to be 2.3 adults/100 km^2. Annual adult survival rates of the radio-collared lynx were 0.73 in 1986 and 1.00 in 1987, and kitten mortality was high at 88 percent with only 1 of 8 known kittens surviving its first year (Koehler 1990, p. 847).

As stated previously, fire is a common disturbance factor in boreal forests (Agee 2000, p. 47). Fire return intervals within western subalpine fir forests in the Cascades range from 109 to 250 years (Agee, 2000, p. 50) with typically high fire intensities in lynx habitat resulting in extensive areas of regenerating forest (Agee, 2000, p. 53). Maletzke assessed the effects of recent fires in the Cascades and their potential impacts to the lynx population there as follows:

> "From 1990-2002, there were about 2,600 km^2 of lynx habitat in the Okanogan (Eastern Cascades) area, and female home ranges were estimated at 39 – 41 km^2, suggesting the potential to support roughly 90-115 resident females (home ranges include "matrix" or non-habitat). By 2014, habitat had been reduced by fire to about 1,600 km^2, and habitat loss and fragmentation resulted in female home ranges increasing to an estimated 91 km^2, with a potential to support roughly 27 resident females" (Lynx Workshop Report 2016, p. 21).

Therefore, using Maletzke's method and assuming a 2:1 sex ratio of females to males, the total theoretical lynx population that may have been supported in the Cascades prior to 2002 may have ranged between 135 and 172 individual lynx. Subsequent to the fires the total theoretical lynx population potentially supported in the Cascades has been reduced to approximately 40 individual lynx, which potentially represents a 70 percent to 77 percent decline in the lynx population. Note: while the area (lynx habitat in the Cascade range) used to generate the population estimate of 55 lynx in the Cascades prior to the fires based on Koehler's (1990, p. 847) lynx density estimate is the same as the area used by Maletzke to generate his population estimate of 90 – 115 resident females based on simulated female home ranges with an empirically derived size and arbitrary minimum threshold of habitat, the two dissimilar population estimates used differing methodologies, and thus the population estimates themselves are not comparable. However, using Koehler's lynx density estimate of 2.3 lynx/100 km^2 and applying it to the 1,600 km^2 of lynx habitat remaining after the fires results in an estimated lynx population of approximately 37 individual lynx, which represents an approximate 33 percent reduction in the lynx population. Further informing the effects of these recent fires in the Cascades on lynx habitat is illustrated by evaluating the average size of a female lynx home range prior to and after the fires. Prior to the fires, Koehler (1990, p. 847) estimated an average female lynx home range size of 39 km^2 (15 mi^2), whereas after the fires Maletzke estimated the average female home range size had increased to 91 km^2 (35 mi^2) (Lynx Workshop Report 2016, p. 21). The important point is the recent large, stand replacing fires in the Cascades has resulted in significant temporary losses of lynx habitat, and thus the ability of the Cascades to support a persistent and viable reproducing lynx population may have been significantly impacted. The

areas impacted by these recent fires are expected to regenerate into suitable lynx habitat, but it may take 35-40 years to do so (Lynx Workshop Report 2016, p. 21).

Factors Affecting Current Condition: In 1993, lynx were classified by the Washington Fish and Wildlife Commission as a state threatened species (Stinson 2001, p. 22). On July 12, 2016, the WDFW recommended that the Washington Fish and Wildlife Commission uplist the lynx from a state threatened to a state endangered species (WDFW 2016, p.1). According to the Draft Washington State Periodic Status Review for the Lynx, the WDFW recommended listing the lynx as endangered due to: 1) observed range contraction in Washington following protection efforts; 2) the substantial loss of habitat in the last 20 years; and 3) the ongoing and anticipated threats to lynx population persistence.

Within Washington, the vast majority of lynx habitat is administered by the Okanogan/Wenatchee (OWNF) and Colville (CNF) National Forests. The North Cascades (aka the Okanogan LMZ in north-central Washington), which supports the only known, long-term persistent lynx breeding population in Washington, and within which critical habitat was designated for lynx in 2014 (79 FR 54782), is administered by the OWNF. Subsequent to listing lynx under the ESA, the Forest Service entered into a Conservation Agreement (CA) with the Service in 2000 (USFS and USFWS 2000, entire), which was revised and extended in 2006 (USFS and USFWS 2006, entire). The CA committed the ONWF and CNF to use the Lynx Conservation Assessment and Strategy (LCAS) for management of lynx and its habitat on their ownerships, and will remain in place until the forests amend or revise their individual LRMPs.

The LCAS, which was also developed pursuant to the listing by an interagency team comprised of USFS, BLM, Service, and NPS personnel, identified four primary risk factors potentially exerting population level effects upon the status of lynx: climate change, vegetation management, wildland fire management, and habitat fragmentation. To promote conservation of lynx and its habitat, the LCAS contains conservation measures addressing the identification and maintenance of lynx habitat (foraging, denning, and connectivity habitats) on federal lands. Toward this end, the LCAS recommends that federal land managers identify and map lynx habitat on their ownerships, and delineate LAUs containing the mapped lynx habitat, within which the effects of management actions on lynx habitat will be monitored and analyzed. The LCAS also recommends that the size of LAUs should be based on the average size of a female lynx home range and contain year-round habitat components (i.e., foraging and denning habitat). Thus, in Washington, and the north Cascades specifically, it appears that the single threat for which lynx were listed under the ESA (i.e., inadequacy of regulatory mechanisms) has largely been addressed through the development of the LCAS, and CA between the Forest Service and Service which commits the Forest Service, specifically for Washington the OWNF and CNF, to use the LCAS in the management of lynx habitat on their ownerships and when designing and implementing projects within LAUs.

The WADNR manages approximately 4 percent of the lynx habitat within portions of each of the delineated LMZs (WADNR 2006, p.9) in Washington State, including the Loomis State Forest that is located in the north Cascades of north-central Washington within the Okanogan LMZ. In

1996, the WADNR developed and implemented a Lynx Habitat Management Plan (1996 Lynx Plan) in response to listing of the lynx as a state threatened species by Washington State (WADNR 1996, entire). Subsequent to federally listing the lynx as threatened under the ESA, in 2006 the WADNR implemented a modified Lynx Habitat Management Plan (2006 Lynx Plan) incorporating new science into its 1996 Lynx Plan pertaining to lynx management (WADNR 2006, entire). Among other things, the WADNR 2006 Lynx Plan contains management standards and guidelines to avoid the incidental taking (as defined by the ESA) of lynx. These standards and guidelines address maintenance of lynx denning and foraging habitat, as well as habitat connectivity within and between LAUs and lynx populations within Washington (i.e., LMZs) and Canada.

For example, the WADNR 2006 Lynx Plan includes, among other things: (1) Encouraging genetic integrity at the species level by preventing bottlenecks between British Columbia and Washington by limiting size and shape of temporary non-habitat along the border and maintaining major routes of dispersal between British Columbia and Washington; (2) Maintaining connectivity between subpopulations by maintaining dispersal routes between and within zones and arranging timber harvest activities that result in temporary non-habitat patches among watersheds so that connectivity is maintained within each zone; (3) Maintaining the integrity of requisite habitat types within individual home ranges by maintaining connectivity between and integrity within home ranges used by individuals and/or family groups; and (4) Providing a diversity of successional stages within each LAU and connecting denning sites and foraging sites with forested cover without isolating them with open areas by prolonging the persistence of snowshoe hare habitat and retaining coarse woody debris for denning sites. The 2006 Lynx Plan also describes how WADNR will monitor and evaluate the implementation and effectiveness of the plan. The WADNR has been managing for lynx for almost two decades, and the Service has concluded that the management strategies implemented are effective. In the final revised critical habitat designation, published in the Federal Register on February 25, 2009 (74 FR 8657–8658), we determined that the benefits of excluding lands managed in accordance with the WADNR 2006 Lynx Plan outweighed the benefits of including them in the designation, and that doing so would not result in extinction of the species. We, therefore, again are considering excluding 164.2 mi^2 of lands managed in accordance with the WADNR 2006 Lynx Plan from the revised lynx critical habitat designation.

Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within the north Cascades (Koehler *et al.* 2008, p. 1523), which has significantly affected the status of and current viability of the lynx population within this geographic unit. As discussed below under *Potential Threats/Stressors/Factors Influencing Viability*, there is significant risk of potential future wildfires to further affect the viability of lynx in this geographic unit. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943), and as discussed below, climate change may similarly affect the future viability of lynx within this geographic unit.

4.2.5 Unit 5 - Greater Yellowstone Area

Unit Description: This geographic unit includes the parts of southwestern Montana and northwestern Wyoming the Service designated as critical habitat (Unit 5) for lynx in 2014 (79 FR 54825-54826). It encompasses approximately 23,691 km^2 (9,147 mi^2) in portions of Carbon, Gallatin, Park, Stillwater, and Sweetgrass Counties in Montana; and Fremont, Lincoln, Park, Sublette, and Teton Counties in Wyoming, with ownership that is 97.5 percent federal (USFS, NPS, and BLM); 2.2 percent private; and 0.3 percent State. This unit includes parts of Grand Teton and Yellowstone national parks and the Bridger-Teton, Custer-Gallatin, and Shoshone national forests, and lands managed by the BLM's Kemmerer and Pinedale Districts. It includes parts of the Absaroka, Beartooth, Gallatin, Gros Ventre, Salt River, Teton, Wind River, and Wyoming mountain ranges. This unit is not directly connected to lynx habitats and populations in Canada or to other DPS populations, although lynx dispersing from the north likely arrived intermittently into the area historically and, more recently, some lynx released into Colorado traveled into and through this unit (see Devineau *et al.* 2010, p. 526). Relative to other DPS lynx populations, this unit is about 145 km (90 mi) southeast of the Northwestern Montana/Northeastern Idaho unit, and roughly 400 km (250 mi) northwest of the Western Colorado geographic unit.

Habitat Description: In northwestern Wyoming and the GYA, lynx are generally associated with Englemann spruce-subalpine fir and lodgepole pine of the Rocky Mountain Conifer Forest vegetation class, as described above (Section 4.1.3) for the northwestern Montana, although this habitat and, thus, lynx typically occur at higher elevations (2,000-3,000 m [6,550-9,850 ft]) in the GYA (McKelvey *et al.* 2000a, p. 245; ILBT 2013, p. 60). Potential lynx habitat in much of the GYA is naturally marginal (patchier and composed in many places of drier forest types), with fewer shrubs and a more open understory, and generally low to marginal hare densities, resulting in a spatially-limited distribution of lynx with large home ranges (Squires *et al.* 2003, pp. 5, 12-13; 68 FR 40090; 71 FR 66010, 66029; 74 FR 8624, 8643–8644; Hodges *et al.* 2009, entire; Berg and Gese 2010, p. 1750; 79 FR 54796; Lynx SSA Team 2016, p. 45). Among the three national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 42 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123).

In Yellowstone National Park, 7,732 km^2 (2,985 mi^2; about 86 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 2,784 km^2 (1,075 mi^2; 31 percent of the park, 36 percent of lynx forest types) is estimated to be potential lynx habitat (68 FR 40086). However, hares were completely absent from more than 36 percent of surveyed stands in Yellowstone National Park, and 96 percent had estimated hare densities below the 0.5 hare/ha threshold thought necessary to support resident lynx (Hodges *et al.* 2009, 870, 873-877). In contrast, estimated hare densities were >= 0.48 hares/ha in all surveyed stands on the Bridger-Teton National Forest in the southern portion of the GYA, with highest densities (1.7 hares/ha) in 30-70-year-old regenerating lodgepole pine stands with dense horizontal cover, and densities of 1.2 - 1.6 hares/ha in mature multi-storied spruce-fir and mixed spruce-fir (containing aspen or lodgepole pine) stands (Berg *et al.* 2012, p. 1483). In the central Wyoming Range in the southern part of this unit, hare tracks were more abundant in seral aspen stands with a

significant spruce-subalpine fir component than in aspen stands with little or no spruce-fir, and hares appeared to be absent from pure aspen stands except where they bordered spruce/fir areas (Endeavor Wildlife Research 2009, p. 4). The only lynx den sites described for this unit (the natal den and a subsequent maternal den of one female in 1998) occurred in a mature subalpine fir-lodgepole pine forest in the Wyoming Range, where coarse woody debris and high sapling density provided dense horizontal cover (Squires and Laurion 2000, pp. 346-347).

Average annual snowfall in this unit ranges from about 127 cm (50 in) in Bozeman and 556 cm (219 in) in West Yellowstone, Montana, on the northern and northwestern peripheries of the unit, respectively, to 280-310 cm (110-122 in) in Alpine, Dubois, and Jackson, WY near the central and southern peripheries, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 8/17/2016). In potential lynx habitats on the Bridger-Teton National Forest in the southern half of this unit, deep snow persisted from late October through May (Berg *et al.* 2012, p. 1481).

Habitat Status: Potential lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 97 percent (23,109 km^2 [8,922 mi^2]) of this unit is in federal ownership, including 18,877 km^2 (7,292 mi^2) in national forests under USFS management, 3,944 km^2 (1,523 mi^2) in national parks managed by NPS, and 271 km^2 (105 mi^2) managed by BLM. As described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2008 and 2010 revised its RMPs for the Pinedale and Kemmerer districts, respectively, to include conservation measures and BMPs for lynx based on the LCAS (BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). On lands with developmental land-use allocations, these amended forest plans and the revised BLM RMPs provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently-applied framework for conserving and restoring important hare and lynx habitats.

As elsewhere in the DPS (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27), winter foraging habitat is likely the most limiting habitat for lynx in this unit, and denning habitat is not thought to be limiting. Standards, guidelines and BMPs in the NRLMD and in revised BLM plans restrict vegetation management activities that could reduce winter snowshoe hare habitat and direct the creation or retention of coarse woody debris in areas where denning habitat may be lacking (USFS 2007, Attachment 1, pp. 2-5; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America,

showing that most of this geographic unit has a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

This unit includes substantial areas in nondevelopmental land-use allocations, including (in addition to Yellowstone and Grand Teton national parks) the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie designated wilderness areas. Among the three national forests that contribute to this unit, 75 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34). Management activities in these areas are unlikely to adversely impact lynx and hare habitats.

Large parts of Yellowstone National Park burned in the extensive wildfires of 1988. Although the extent to which those fires may have impacted potential lynx habitats is uncertain, some of the burned areas may soon reach a stage of regeneration capable of supporting increased densities of hares, perhaps increasing the likelihood that lynx could reestablish and maintain home ranges in some parts of the park (Lynx SSA Team 2016, p. 45).

Because non-federal lands make up less than 3 percent of lynx habitats in this unit, it is unlikely that activities on those lands have impacted lynx populations or meaningfully influenced the unit's current capacity to support resident lynx.

Overall, although naturally fragmented and patchily-distributed, potential lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway, railroad) development, past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

In summary, much of this geographic unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental land-use allocations, where management activities with the potential to adversely affect lynx habitat generally do not occur. Almost all lands with developmental land-use allocations in this unit are managed by the USFS to conserve and maintain lynx and hare habitats under management plans that were formally revised in 2007 in accordance with the NRLMD and based on the scientific findings and conservation recommendations of the LCAS. A small proportion of lands with developmental allocations occurs on BLM lands where management plans also were revised recently (2008 and 2010) to adopt conservation measures identified in the LCAS. Implementation of these USFS and BLM plans likely precludes landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places. Additionally, because lynx habitats in this unit are naturally highly-fragmented and, in most places, support low landscape-level hare densities, relatively minor impacts, especially to hare and lynx winter foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit. As described in section 2.3.2.2 above, the historic record and recent research show that the GYA has supported resident lynx, but it is unclear whether the area consistently supported a persistent resident population over time or whether it naturally supported resident lynx only intermittently. Most historic and recent verified lynx records are from the southern portion of this unit in the Gros Ventre, Salt River, Wind River, and Wyoming mountain ranges in the Bridger-Teton National Forest. Eighteen lynx were reported to have been trapped from a small area in the Wyoming Range in 1971-72 (Squires and Laurion 2000, p. 338), but it is unknown whether any of those lynx were residents (and if so, how many) or if some or all of them were dispersers associated with the "explosion" (irruption) of lynx documented in several places in the contiguous U.S. in the early 1970s (McKelvey *et al.* 2000, pp. 235-242). However, two resident lynx, a male and a female, were trapped, radio-marked, and monitored in the Wyoming Range over several years beginning in 1996. The female produced four kittens in 1998 and two in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000 (Squires and Laurion 2000, p. 346; Squires *et al.* 2001, pp. 9, 26). The female's home range averaged 50 km^2 (19 mi^2) over the 3 years she was monitored, and the male's averaged 824 km^2 (318 mi^2) over five years (Squires *et al.* 2003, pp. 12-13). The male also made multiple long-distance exploratory movements (up to 728 km [452 mi], including multiple highway crossings) over 3 successive years (Squires *et al.* 2003, pp. 13-16; Squires and Oakleaf 2005, entire).

Other surveys also detected lynx in the southern portion of this unit from 1999-2009, with records most consistent in the Wyoming Range, Togwotee Pass, Union Pass, the Bondurant Corridor, and in the Gros Ventre Range (Squires *et al.* 2001, pp. 9-14; Squires *et al.* 2003, pp. 9-11, 29-31; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Squires *in* Lynx SSA Team 2016, pp. 20-21). Additionally, 10 radio-marked lynx released in Colorado subsequently moved into or through this portion of the GYA unit from 2004-2010, with locations concentrated in areas used previously by native Wyoming lynx (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.). Several of the Colorado-released lynx occupied home ranges (including overlapping male and female home ranges) in areas of the Wyoming Range previously occupied by "native" resident lynx (Squires *in* Lynx SSA Team 2016, p. 21), but there is no evidence of reproduction among these lynx. On the Shoshone National Forest in the northeastern part of this unit, seven lynx snow tracks were confirmed by DNA analysis in winter 2005/06, and a single track was verified the following winter (Endeavor Wildlife Research 2008, p. 2; Berg 2016, pers. comm.). During the winters of 2004-05 through 2007-08, 26 snow tracks on the Bridger-Teton and Shoshone national forests were confirmed by DNA analyses to be from five individual lynx (3 males, 2 females). One of the males had previously been documented in Yellowstone National Park (see below). The other two males and both females were lynx that had been released in Colorado (Pilgrim 2016, pers. comm.).

Verified records of lynx are less common elsewhere in this unit, including in Yellowstone and Grand Teton national parks and the Custer-Gallatin National Forest. There were no verified records of lynx in Yellowstone National Park from 1920-1999 (McKelvey *et al.* 2000, p. 230); however, surveys in 2001-2004 documented at least 3 individual lynx, including two kittens, in

the eastern part of the park (Murphy *et al.* 2006, entire). Several Colorado-released lynx also traveled through the park (Devineau *et al.* 2010, p. 526), and two possible (unconfirmed) lynx tracks were recorded in the park during winter 2008/2009 (Endeavor Wildlife Research 2009, pp. 4, 12). On the Custer-Gallatin National Forest in Montana in the northern part of the unit, a single female was detected over six consecutive winters (2003/2004 - 2008/2009) but not subsequently (Gehman *et al.* 2010, pp. 2-4), and it appears that she did not encounter a male or produce kittens during the six years she was detected (Gehman *et al.* 2010, p. 4).

Recent surveys and research-related trapping efforts have failed to detect lynx in this unit after 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45; Hanvey 2016, pers. comm.). As discussed above and in section 2.3.2.2, it is uncertain whether this unit historically supported a small but persistent resident population that was recently extirpated, or if it historically and recently has supported resident lynx only intermittently. Given the protected conservation status of millions of acres in this unit, its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx (Lynx SSA Team 2016, p. 57). Conversely, the characteristics described above suggest that relatively small impacts could tip this unit from just barely able to support a persistent resident population to incapable of doing so. Further, the available evidence suggests that if this unit did support a persistent population, it was very likely a very small one, which would be more vulnerable to extirpation due to demographic, environmental, and genetic stochasticity, and to catastrophic events (McKelvey *et al.* 2000b, pp. 23-29), or to a combination of these factors.

Factors Affecting Current Conditions: *Regulatory Mechanisms* - As described above for Unit 3, federal management activities (e.g., timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level to threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. Current regulatory mechanisms and conservation measures associated with recently amended or revised federal management plans are intended to conserve and restore lynx and hare habitats across large landscapes. Although their effectiveness has not been quantitatively evaluated, they have almost certainly reduced significantly the potential for adverse management-related impacts to lynx habitats in this unit.

Lynx trapping has been prohibited in Wyoming since 1973 (79 FR 54794) and in Montana since 1999 (MTFWP 2016, p. 7) and, as described in section 3.1.2, above, both states require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, no lynx are documented to have been incidentally trapped in the Montana portion of this unit (MTFWP 2016, pp. 5-10) and we are aware of no incidental captures in northwestern Wyoming since listing.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Mote *et al.* 2005, entire; Pederson *et al.* 2013; Riley *et al.* 2013; Dennison *et al.* 2014, entire; USEPA 2015, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities low in some places, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609).

Vegetation Management - The influence of vegetation management on the current condition of lynx and habitats in this unit is described above under Habitat Status and *Regulatory Mechanisms*.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, likely in response to climate warming and related increases in drought conditions (e.g., Dennison *et al.* 2014, entire; Harvey *et al.* 2016, entire; Westerling 2016, entire), with most large, stand-replacing fires having occurred in the northern part of the unit, in Yellowstone National Park (see Harvey *et al.* 2016, Fig. 1). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to continue to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction on lands with

developmental allocations. Much of this unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental allocations. Even in areas with developmental allocations, the moist subalpine forests important to lynx have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx. Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Wyoming (1; a Colorado-released lynx) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates of are unknown. Although this unit is not directly connected to lynx habitats and populations in Canada or elsewhere in the contiguous U.S., no barriers to lynx dispersal from the north have been identified, and 10 lynx released in Colorado are known to have dispersed northward into and through this unit (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.), demonstrating that dispersal between the southern and northern Rockies is possible. As described above in Lynx Status, the large number of lynx reportedly trapped from a small area of the Wyoming Range in the early 1970s (Squires and Laurion 2000, p. 338) may suggest dispersers associated with the irruption of many lynx from Canada into the northern contiguous U.S. documented at that time (McKelvey *et al.* 2000, pp. 235-242). No subsequent pulses of lynx dispersing from the north have been documented, and lynx trapping records suggest that the magnitude of lynx populations cycles in Alberta and British Columbia, the most likely source of lynx dispersing southward into this unit, dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

As described in section 3.2, above, a number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this geographic unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, it is possible that it has contributed to the recent apparent loss of resident lynx from this unit.

4.2.6 Unit 6 - Southern Rockies Geographic Area

Unit Description - The overall geographic unit includes Colorado, south-central Wyoming, and north-central New Mexico. However, within the southern Rockies, since we currently have no evidence of resident lynx in southern Wyoming or northern New Mexico, and we question the ability of these two areas to support breeding populations we are not including these two areas in the unit description. Lynx habitat in Colorado totals approximately 25,294 km^2 (9,766 mi^2), and is distributed west of US Interstate-25. We excluded the northwest part of the state bounded on the south by US Interstate-70 and the east by Colorado State Highway 13, because this area lacks sufficient habitat to support lynx. Lynx habitat in Colorado falls within the following land ownerships, USFS 21,555 km^2 (8,322 mi^2), BLM 772 km^2, (298 mi^2), NPS 452 km^2 (174 mi^2), Private 2,350 km^2 (907 mi^2), State 164 km^2 (63 mi^2).

The southern Rockies are separated from the rest of the Rocky Mountain chain, and thus lynx habitat in northern and western Wyoming, by sagebrush and desert shrub communities in the Wyoming Basin and the Red Desert of southern and central Wyoming, and the arid Green and Colorado River plateaus of western Colorado and eastern Utah. Connectivity of lynx habitat has been identified as an important consideration for the southern Rockies, because of the extreme topographic relief juxtaposed with human developments such as highways and residential communities.

Habitat Description - Lynx habitat in the southern Rockies is found within the subalpine and upper montane forest zones, generally above 2,900 m (9,514 ft) elevation (Shenk 2009 page 10). In the upper elevations of the subalpine zone, forests are typically dominated by subalpine fir and Engelmann spruce. As the subalpine zone transitions to the upper montane, spruce-fir forests begin to give way to lodgepole pine and aspen. On cooler, mesic mid-elevation sites, Engelmann spruce may retain dominance, intermixed with aspen, lodgepole pine, and Douglas-fir. Lodgepole pine reaches its southern limits in the central part of the geographic unit, while southwestern white fir occurs only in the San Juan Mountains. The lower montane zone is dominated by ponderosa pine and Douglas-fir, with pines typically dominating on lower, drier, more exposed sites, and Douglas-fir occurring on the more sheltered sites. Lower montane forests do not support snowshoe hares and seldom would be used by lynx.

Mature Engelmann spruce/subalpine fir forests with total canopy cover of 42–65 percent, of which 15–20 percent was contributed by conifer understory tree canopies, were the most commonly used areas, followed by mixed forests of Engelmann spruce/subalpine fir/aspen (Shenk 2008, page 15). Riparian and riparian-mix was the third most-used cover type, with a pattern of increasing use beginning in July, peaking in November, and dropping off in December. Large or medium willow/alder carrs and willow riparian communities provided important habitat for snowshoe hare, grouse, ptarmigan (winter), and other prey species that could be utilized by lynx.

Ivan *et al.* (2012 page 5) confirmed some relationships that were already known (e.g., lynx are strongly associated with high-elevation spruce/fir and mixed spruce/fir forests but avoid lower-

elevation montane forests and montane shrublands). We recognize that all spruce-fir forest does not support lynx equally based on the low detection rate (28 percent) reported during the ongoing lynx study in the San Juan Mountains within predominantly spruce-fir forest (Ivan, Workshop presentation 2015, p. 14), thus not all areas of spruce-fir forest are used by lynx.

Dolbeer and Clark (1975 page 539) estimated a density of 0.73 hares/ha (0.3 hares/ac) within their study site in Colorado, with the highest densities of snowshoe hare in mature and late-successional spruce-fir forests. However, this study was conducted in a very limited area and did not sample younger sapling-stage stands (15-40 years post-disturbance) to compare hare densities with those reported for mature and late-successional spruce-fir forests (USFWS 2008, p. 32).

Habitat that supports snowshoe hares is patchily distributed in the Southern Rocky Mountains Geographic Unit, which limits their abundance. Zahratka and Shenk (2008 entire) found densities of snowshoe hares to be greatest in mature Engelmann spruce-subalpine fir stands when compared to mature lodgepole pine stands in Taylor Park, Colorado. Their density estimates were 0.08±0.03 to 1.32±0.15 hares/ha (0.03–0.5 hares/ac) in Engelmann spruce-subalpine fir habitats, and 0.06±0.01 to 0.34±0.06 hares/ha (0.02–0.14 hares/ac) in lodgepole pine habitats (Zahratka and Shenk 2008 entire).

Ivan (2011*a in ILBT 2013*) compared snowshoe hare density, survival, and recruitment in mature uneven-aged spruce/fir stands, small-diameter lodgepole pine (2.54–12.7 cm [1–5 in]) stands (20–25 years old), and medium-diameter (12.7–22.9 cm [5–9 in]) previously-thinned lodgepole pine stands (40–60 years old) in Colorado. During summer, Ivan (2011*a* in *ILBT 2013*) recorded densities of 0.2+0.01 to 0.66+0.07 hares/ha (0.08–0.27 hares/ac) in small lodgepole pine forest, 0.01+0.04 to 0.03+0.03 hares/ha (0.004–0.01 hares/ac) in medium lodgepole forest, and 0.01±0.002 to 0.26±0.08 hares/ha (0.004–0.1 hares/ac) in spruce/fir forest; densities were more similar across the 3 forest types during the winter months. He concluded that “hares reached their highest densities and recruited juveniles most consistently in stands of small lodgepole, followed closely by spruce/fir, but survival was highest in spruce/fir stands.”

Habitat Status - At the time of the 2000 listing, we identified 26,305 km^2 (10,156 mi^2) of potential lynx habitat in the Southern Rockies (i.e., Colorado and southern Wyoming) [65 FR 16052). In 2003, we estimated 31,027 km^2 (12,419 mi^2) of potential habitat within the southern Rockies (68 FR 40076). As stated above, our focus here is limited to the state of Colorado. In 2008, the USFS reported that most of their LAUs in the southern Rockies fell within a range of 3-8 percent in a currently unsuitable condition, with only one LAU exceeding 30 percent unsuitable (USFS 2008, p. 19). Currently, the USFS reports 51 out of 202 (25%) LAUs currently exceed the 30 percent unsuitable condition (P. McDonald 2016, pers. comm.). These changes are mostly in response to the ongoing bark beetle infestations, as well as wildfire events that have occurred since 2008.

Ivan *et al.* (2012, p. 6), developed a predictive map of lynx habitat use by using lynx location data collected during CPWs reintroduction monitoring, then estimated the amount of habitat associated with a high probability of detecting lynx. Our review of the vegetative characteristics of CPW's predictive map detected large areas of spruce-fir habitats that were excluded by their presentation of the habitat associated the top 20 percent of predicted use. Therefore, we selected the top 30 percent of the Ivan *et al.* (2012, entire) predictions and the associated habitat to represent the amount of potential lynx habitat in Colorado totaling 25,294 km^2 (9,766 mi^2). This habitat estimate falls between the Ivan *et al.* (2012, p. 6) estimate and the USFS's habitat estimate of 30,664 km^2 [11,839 mi^2] (USFS 2008, p. 18), while retaining a greater than 60 percent probability of detecting lynx as described by Ivan *et al.* (2012).

Regulatory mechanisms in Colorado are largely provided through Forest Service planning documents. All USFS land management plans within the unit were amended in 2008 to provide for the conservation of lynx. Three BLM plans in Colorado have been amended or revised to conserve lynx following the 2013 LCAS, totaling approximately 126 km^2 (49 mi^2). One additional plan provides conservation measures for timber management actions only, but the FO contains only about 1 km^2 (0.39 mi^2). The remaining FOs currently have not amended or revised their plans specifically to provide conservation for lynx (approximately 645 km^2 (298 mi^2), Since the 2000 listing however, all BLM Field Offices in Colorado have been conserving lynx discretionarily through application of conservation measures provided in the Lynx Conservation Assessment and Strategy (Ruediger *et al.* 2000, entire; ILBT 2013, entire). Rocky Mountain National Park has a fire management plan that includes conservation measures for lynx. We are not aware of any specific conservation planning guiding activities on non-federal lands (M. Wrigley 2016, pers. comm. ; M.K. Watry 2016, pers. comm.).

Lynx Status - As of 2016, the current distribution of lynx is somewhat uncertain within Colorado. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell 2016, undocumented pers. comm.), and Rocky Mountain National Park (Shenk 2008, p. 3). The CPW is developing a minimally-invasive, long-term, statewide monitoring program to track the distribution, stability, and persistence of lynx in Colorado (Ivan 2012, entire).

As of 2015, evidence of recent lynx reproduction is provided through kittens captured on game cameras accompanying adult females at three locations during 2014-2015 monitoring effort (Ivan presentation 2015 page 17). In addition 38 percent of lynx captured during recent (2010-2015) USFS Rocky Mountain Research Station research projects in Colorado have been young and/or unmarked cats (Ivan *in* Lynx SSA Team 2016, p. 17), suggesting continued reproduction within Colorado. However, reproductive rates are currently unknown.

As of 2007, the average probability of survival for reintroduced lynx was 0.9315±0.0325 within the study area in the San Juan Mountains and 0.8219±0.0744 outside the study area boundary (Devineau *et al.* 2010, page 5). Although 30 percent of known mortalities were due to human causes (being shot or hit by a vehicle), the estimate of survival within the study area was higher than those reported for natural, lightly trapped populations of Canada lynx in the Yukon (0.75–

0.90; Slough and Mowat 1996 entire, O'Donoghue *et al.* 1997, page 155) or in the Northwest Territories (~0.90; Poole 1994, page 612). Successful reproduction, including by females born in Colorado, has been documented (Shenk 2008, page 2), and kitten survival was 0.2260 (Jake Ivan, pers comm. March 9, 2016).

Factors Affecting Current Conditions - Colorado is currently experiencing major bark beetle epidemics in lodgepole pine and spruce-fir forests. Although bark beetles are native insects, and forests in the western U.S. have experienced regular insect infestations throughout their history, the current bark beetle epidemic is notable for its intensity and extensive geographic range. The causes of this epidemic include: relatively even-aged, dense, and homogenous forest conditions, which are highly susceptible to beetle attack, and which were created by large-scale logging in the late 1800s and subsequent fire suppression efforts; warmer winters due to climate change (cold winters typically reduce beetle populations); and a multi-year drought that occurred in the mid-1990s through early 2000s, stressing the trees and making them more susceptible to beetle attack (USFS 2011, pp. 4).

In lodgepole pine forests, a mountain pine beetle (*Dendroctonus ponderosae*) epidemic typically kills the entire overstory and results in a stand-replacing disturbance event. In Colorado, more than 1,375,931 ha (3,400,000 ac) has been affected by mountain pine beetle, and 639,000 ha (1,579,000 acres) affected by spruce beetle since 1996 (USFS 2015, p. 3), a portion of which overlaps with lynx habitat.

Even-aged mature and "dry" lodgepole pine stands characteristically have depauperate understory vegetation and are not capable of supporting dense populations of snowshoe hares. On moist sites, regeneration of beetle-killed lodgepole pine stands is expected to be relatively rapid 20-30 years, and the new stands will be dominated by resprouting aspen or by a new cohort of lodgepole pine. If these newly-established stands grow tall and dense enough to provide horizontal cover above the snow layer, they may produce excellent habitat for snowshoe hares and lynx for several decades, until the crowns again lift above the reach of snowshoe hares.

A spruce beetle epidemic kills the larger-diameter trees and can also result in a stand-replacing disturbance event. Because of the importance of spruce-fir forests for production and survival of snowshoe hares (Ivan 2011a in ILBT 2013), widespread mortality of mature spruce/fir forests could impact lynx habitat for a long duration. By 2015, the spruce beetle outbreak influenced approximately 95 percent of the mature spruce component of the subalpine cover types on the Rio Grande National Forest (Squires *et al.* unpublished report 2016, page 1). Despite the large scale, and almost complete mortality of the mature spruce component within their study area, lynx continue to use and reproduce in the beetle-infested forests (Squires *et al.* unpublished report 2016, page 2). Since the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. However, habitat connectivity may be negatively affected by intense recreational use or development within strategic areas that are important for habitat connectivity.

ILBT (2013 p. 57; 61-62) states:

> *Plague, a flea-borne disease caused by the bacterium Yersinia pestis, which is not native to North America, was reported for the first time in lynx in Colorado (Wild et al. 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 reintroduced lynx between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to Y. pestis; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado.*
>
> *Vehicular collisions are a potentially important cause of mortality for lynx in portions of the southern Rockies. Thirteen of 102 mortalities documented for lynx translocated into Colorado were from vehicle collisions (Devineau et al. 2010). Brocke et al. (1990) suggested that translocated animals might be more vulnerable to highway mortality than resident lynx and this could have been a factor in Colorado at the time of listing. Currently, the majority of lynx mortalities caused by vehicle collision (13 of 16) occurred during the reintroduction period (1999-2006). Since early 2007, one year after the final reintroductions occurred, only 3 hit by vehicle mortalities have been reported, and only two of those occurred in Colorado (Broderdorp unpublished data 2016). A number of highways with high speed and high traffic volume pass through lynx habitat, such as I-70, I-80, US 50, US 550 and US 160. These highways are not a barrier to lynx movement, as repeated successful crossings by radio-telemetered lynx have been documented on I-70 and Highways 9, 40, 50, 91, and 114 (Ivan 2011b, c, 2012; J. Squires, personal communication 2012). At this time, it appears that hit by vehicle mortality may be a less significant mortality factor for lynx in Colorado.*
>
> *As compared with other portions of the range of lynx, in Colorado more winter recreation and associated development overlaps with lynx habitat. Preliminary information from a study in Colorado indicates that some winter recreation uses may be compatible, but lynx may avoid some developed ski areas (J. Squires, personal communication 2012). It is possible that ski areas and 4-season resorts may reduce the amount and availability of lynx habitat within localized areas, in part by influencing the distribution or abundance of prey resources within the developed area. However, there is also considerable anecdotal evidence of lynx using ski areas.*
>
> *Leg-hold trapping is currently prohibited under the state constitution of Colorado as a means of predator control or for commercial and recreational trapping. If a landowner can prove that all other non-lethal methods have been ineffective, a 30-day exemption may be granted for depredation cases. Incidental trapping mortality of lynx may be a minor risk during trapping seasons in southern Wyoming and surrounding states.*
>
> *Predator control activities on federal lands, including coyote shooting or trapping, are common throughout most of this geographic area, mostly related to the grazing of domestic sheep. The majority of sheep grazing occurs on arid rangelands, but some*

grazing does occur during summer at the higher elevations, especially in south-central Colorado. Incidental capture of lynx is possible, but unlikely.

Chapter 5: Future Conditions

In this chapter, we present our assessment, based on the best available scientific information, ncluding the professional judgment and opinions of lynx experts, of the ~~potential~~ future ~~status~~condition of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the likely future conditions in each geographic unit, followed by a more detailed evaluation of the factors likely to influence lynx populations and habitats in each unit. We present and summarize the professional judgments and opinions of a panel of 10 lynx experts regarding the factors likely to influence the persistence of resident lynx populations in the DPS as a whole and in each of the ~~six~~6 geographic units. We also present and summarize the experts' projections, based on consideration of those influencing factors, of the probability that each of the geographic units will continue to support resident breeding populations of lynx into the future (at years 2025, 2050, and 2100). We then provide additional Service review of the influencing factors described in Chapter 3, above, and their potential effects on the ability of each geographic unit to support lynx populations in the future.

5.1 Summary of Future Conditions DPS-wide

Given the irresolvable uncertainty about the historical distribution of resident lynx in the contiguous U.S. and the current lack of reliable estimates of the sizes, trends, and many demographic parameters for most DPS populations, it is difficult to confidently predict the future ~~status~~condition of the DPS or the likelihood that any given geographic unit will support resident lynx in the future. We lack data to build rigorous empirical population models for lynx in the DPS, and uncertainty regarding the timing and magnitude of potential impacts to lynx from continued climate warming also limits our ability to predict the future condition~~s for~~of the DPS. Therefore, our assessment of the future condition of the DPS is based on the best professional judgments and opinions of lynx experts and our evaluation of the available scientific information regarding the factors identified by the ILBT as the most likely to have population-level impact to lynx in the DPS (ILBT 2013, pp. 68-78).

Overall, expert opinion and our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). This outcome seems likely

Comment [MJM31]: We need to explain the context for this analysis of future conditions. This context includes the absence of ESA listing and the protections it provides (no section 9 prohibitions, no section 7 consultation, etc.). This context is important to avoid the circular outcome that ESA listing is unwarranted because the species is sufficiently protected from threats due to its listing under the ESA.

Was this context explained to the experts who provided input?

Comment [MJM32]: This assessment of future condi ions focuses on the "likely" outcome of he threats acting on the species. This focus on only the likely outcome is essentially a single future scenario analysis. Our SSA Guidance directs us to look at a range of future scenarios so as to capture he full risk to the species. A risk analysis requires an assessment of the full range of plausible futures and their probabilities. Even when a "good" future for the species is likely, lower likelihood "bad" future scenarios can individually or cumulatively cons itute sufficient risk to the species to warrant listing.

Comment [MJM33]: This sounds like we consider expert opinion as constituting the best available science/information. Opinions, by hemselves, can never constitute best available information. We should never simply refer to expert opinion as the basis of our conclusions. We must draw our own independent conclusions. Our conclusions can be informed by expert opinion, but we must explain the reasons the experts hold their opinions, explain why we agree or disagree with this reasoning, and then arrive at our own conclusions (making it clear that these are our conclusions). We can hen say "Based on the best available ...

Comment [MJM34]: Use "future condition" or "population status" to avoid confusion with lis ing status (E/T).

Comment [MJM35]: This is an example of where we incorrectly refer to expert opinion as something we consider "in addition to" he best available science. We can consider ONLY the best available science. Our understanding/analysis of the best available science is informed by expert opinion.

Comment [MJM36]: We need to also consider the risks posed by factors that may be of a lower likelihood but still meaningful.

Comment [MJM37]: This paragraph seems to be describing "our" overall conclusions. But it's confusing when it refers to the experts' opinions. We don't need to refer to the experts' opinions when we are presenting our conclusions. We should clearly establish in the introduction to his sec ion where our conclusions come from.

Comment [MJM38]: We need to also consider the risk posed by the less-than-likely probability that he sizes and distributions of populations will be reduced even more.

regardless of which climate emissions scenario is used to model future conditions, although the timing, extent, and magnitude of impacts is uncertain and will likely vary by scenario.

In addition to climate change, forest management also has the potential to influence (negatively or positively) hare and lynx habitats in the DPS range. Forest management on private lands that lack lynx conservation commitments may contribute to future declines in the amount and quality of lynx habitats, particularly in Maine and perhaps also in Minnesota (private lands contribute minimally to lynx habitats in the other geographic units – see ~~T~~table 1, above). Uncertain future forest ownership and markets for forest products, shifts in silvicultural practices, and development pressures on private lands all may affect the resiliency of future lynx populations and thus the units. The lack of evaluation of the effectiveness of forest management plans for lynx on ~~f~~Federal lands is of concern for western units.

In each geographic unit, the probability that resident lynx populations will persist is expected to decline in the future, although uncertainty about persistence probability increases with time from the present (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below). Although all five geographic units that currently support resident populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century. All other geographic units have a 50-percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below), with a moderate to high likelihood that resident lynx will be lost from two to four units by then (~~F~~figure 7).

Comment [MJM39]: I don't understand what his is saying. Is it trying to say the probability of persistence declines as we look further out into the future? If so, this is a meaningless statement because it could be said of every species on earth. We need to convey the magnitude of the decline.

Comment [MJM40]: What do we expect?

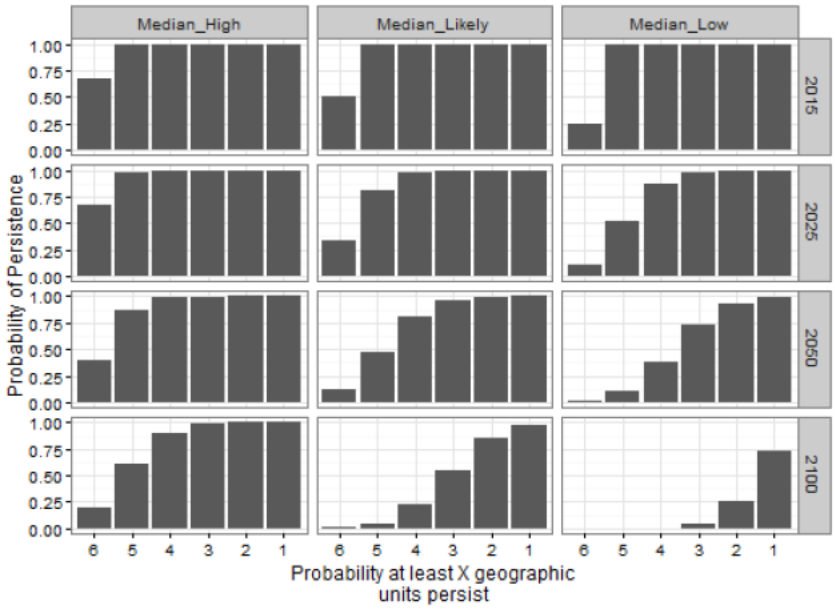


Figure 7. Summarized probability of persistence of at least a given number of geographic units given the probability of persistence for each individual geographic unit. The y axis of each grid in ~~F~~figure 7 is the probability that at least the number of geographic units indicated by the x axis of the grid persist. The probability in a bar reaches 1 when there is no probability of fewer geographic units persisting. Moving from top to bottom the grids show the probabilities by time period (2015, 2025, 2050, and 2100). Moving from left to right the grids show the range of expert responses by summary selection type and probability response. Therefore, looking down a column of grids provides a view of the trend in persistence through time and looking across a row of grids provides a view of the range of uncertainty in persistence for a given time period.

The loss of all resident lynx from one or more geographic units would represent reduced future redundancy, representation, and resiliency within the lynx DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (e.g., additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is

Comment [MJM41]: The title of the figure and he text should make clear that this is a summary of expert opinions.

Presenting the experts' opinions as line graphs and bar graphs makes it seem as if we are treating these opinions as data – as the best available science. They are only opinions. These opinions can inform our conclusions about how we interpret the science, but only after we have analyzed the reasoning behind hem.

Comment [MJM42]: This better portrays that we are drawing our own conclusions. Using the word "input" rather than "opinions" is a better way to get across the idea that it is the reasoning behind the opinions that matters. "Input" seems to capture both the opinions and he reasoning behind them.

Comment [MJM43]: What about climate change? Shouldn't we qualify his as we do below for the statement about extirpation of the whole DPS?

Comment [MJM44]: Recommend stating his as a probability. "Could" means "possible." I suspect the intended meaning is that it's highly unlikely, not that it's impossible.

Comment [MJM45]: But we didn't say how likely the first claim is that this claim is being compared to.

Comment [MJM46]: What is he likelihood of such a series of events? This statement has no benefit to the analysis without stating the likelihood.

Comment [MJM47]: Of what? A geographic unit or the whole DPS?

uncertain, there seems to be little risk of significant genetic drift. This is because of the currently- observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and likely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Based on expert input, there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS.

How the potential loss of resident lynx from one or more geographic units may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

In terms of resiliency, expert opinion and our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

5.1.1 Summaries of Future Conditions in Each Geographic I Unit

Unit 1 – Northern Maine: Although the Northern Maine geographic unit currently has extensive lynx habitat, it may be one of the units in the DPS at greater risk. Forestry practices and climate change will be the greatest future drivers of hare and lynx habitat. Lynx habitat and numbers are expected to decline by 50 to 60 percent by 2032 in response to aging of the budworm-era clearcuts and the effects of 27 years of extensive partial harvesting. In the next few decades,

Comment [MJM48]: But what is he likelihood hat the level of gene flow will not be high? To say there is little risk of genetic drift, we need to be able to say the likelihood is very low hat gene flow will be reduced to a level that would cause his problem. It's apparent that the likelihood is something less than likely, but "less han likely" is not necessarily "very low."

Comment [MJM49]: This better portrays that we are drawing our own conclusions. Using the word "input" rather than "opinions" is a better way to get across the idea that it is the reasoning behind the opinions that matters. "Input" seems to capture both the opinions and he reasoning behind them.

Comment [MJM50]: Again, we don't need to keep referring to expert opinion when presenting "our" conclusions.

Comment [MJM51]: This is a meaningless statement. We need to describe the magnitude of this decline in probability.

high quality hare habitat will drop from about 10 percent to 5 percent of the landscape. High quality habitat patches will become more fragmented, smaller, and more isolated, thus making the landscape less suitable for lynx. For the next few decades the best habitat will occur in the southern portion of the range where effects of climate change and competition with bobcats are likely to be greatest. Absent long-term lynx management agreements, the future of lynx habitat is uncertain. Wood products markets will continue to change, and could be affected by interest in carbon sequestration in response to climate change. Rapid changes in private forest land ownership are likely to continue resulting in subdivision of large ownerships. Changing land uses (wind energy development, transmission line corridors, residential land development, national monument) will compete with forest management as the primary land use. Conservation easements will help reduce development pressures and keep some lands as working forest. Climate change is expected to affect the Maine unit more than others in the DPS because snow depth and duration already seem to be at thresholds for lynx and there are few potential elevational refugia. In the near term and to mid-century, snow quantity and quality will continue to deteriorate, likely causing the range of lynx to begin contracting northward. In the long term (to 2100), some believe lynx could become extirpated from the unit. Climate change, increasing demand for hardwood forest products, a pending spruce-budworm outbreak, and frequent disturbance of the forest all will contribute toward the trend in the loss of spruce-fir forest and expansion of northern hardwoods, although the timeframe for conversion is uncertain. Lynx experts indicate the probability of persistence will decline to about 50% by the end of the century. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, lack of elevational refugia), some members of the Service's SSA team were more pessimistic about the future of lynx in Maine than the lynx expert panel. There is great uncertainty about the future of forest management and future development on private forest lands. There are no long-term management plans in place, State forest regulations have greatly influenced harvesting practices that have (and will continue to) reduce landscape hare densities, markets for forest products are depressed, and projections (under current harvest scenarios) are that habitat will diminish and shift southward in the near term because of post-harvest succession and recede northward over the longer-term because of continued climate warming.

Comment [MJM52]: This is exactly what we need to do with all he experts' opinions – explain why we agree or disagree. Where is his analysis?

Unit 2 - Northeastern Minnesota: The direct and indirect effects of climate change are expected to affect lynx into the future in Minnesota. Specifically, there is an expected decline in the quantity, quality, and duration of snow; increased competition and hybridization with bobcats; northward contraction of boreal conifer forest; and increased isolation due to diminishing forest conditions in Ontario. The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century, driven in the near term by the quality, quantity and persistence of snow, competition, disease, and forest insects, and over the long term from the some of the same reasons with the addition of climate change, loss of spruce-fir forests, and wildfires. If the SNF in Minnesota continues to follow vegetation management and other recommendations under the LCAS in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue on State and private

lands. Taking all factors into consideration (i.e., loss of boreal forest, increased competition, potential disease and insect outbreaks, loss of snow), lynx experts projected the mean probability persistence of lynx in Minnesota to the year 2025 was greater than 90 percent, to 2050 was 80 percent, and would decline to approximately 35 percent by 2100.

Comment [MJM53]: What do WE project and why?

Unit 3 - Northwestern Montana/Northeastern Idaho: As in other units, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Fire- and insect-related habitat losses would likely be temporary, resulting subsequently in improved habitat conditions when impacted areas regenerate the dense vegetative structure conducive to hare abundance. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Lynx experts felt that future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Considering the factors above, lynx experts felt this geographic unit has the highest likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence > 0.95), at mid-century (median = 0.90), and end-of-century (median = 0.78), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units.

Comment [MJM54]: What do WE conclude?

Comment [MJM55]: What do WE conclude and why?

Unit 4 - North-central Washington: Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within north Cascades, which has significantly affected the status of and current viability of the lynx population within this geographic unit. Similar to the other geographic units, climate change is anticipated to reduce the future quality and distribution of lynx habitat in Washington, potentially further exacerbating the recent temporary losses of lynx habitat from wildfires. Climate change may increase wildfire frequency and severity, which may result in further temporary losses of lynx habitat. Climate change may also decrease the quantity and quality of snow resulting in permanent reductions in the quantity and distribution of lynx habitat in Washington State. These potential climate change driven reductions of lynx habitat may serve to further isolate lynx populations within Washington State as well as between neighboring lynx populations in the other geographic units and Canada. Continued forest management on both federal and State lands will benefit lynx populations in Washington, but this may not completely ameliorate the potential negative effects related to climate change. Considering the recent reduction in lynx habitat and the projected impacts of climate change, experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), mid-century persistence at 30% to 80% (median = 70%), and end-of century (year 2100) persistence probabilities less than 50% (median = 38%) for lynx populations within this geographic unit.

Comment [MJM56]: What do WE predict and why?

Unit 5 - Greater Yellowstone Area (GYA): As elsewhere, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Because potential habitats in much of this unit already are naturally highly fragmented and perhaps only marginally capable of supporting resident lynx, and because it appears to have never supported more than a small number of residents, its ability to do so in the future is tenuous. Lynx experts felt that the small number of lynx this unit appears capable of supporting and its relative isolation from other lynx populations make it more vulnerable to genetic drift and extirpation due to catastrophic events or demographic or environmental stochasticity. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Considering the factors above, lynx experts felt this geographic unit has the lowest likelihood of supporting resident lynx into the future in the near term (year 2025; median probability of persistence = 0.52), at mid-century (median = 0.35), and end-of-century (median = 0.15), with a declining probability of persistence and greater uncertainty with increasing time from present, as in all units.

Unit 6 - Western Colorado: Climate change is expected to affect vegetation and influence snow conditions within the Western Colorado unit. The elevation gradient in Colorado may provide refugia from deteriorating snow quality, depth, and duration throughout the period. Climate models suggest a 40 percent decline in snow persistence, but large areas of snow persistence will remain through the end of the century. Experts suggest that beetle kill and fire will result in unsuitable habitat conditions. However, these areas are likely to regenerate and provide excellent habitat conditions to support hares and lynx. A caveat to future habitat conditions in light of climate warming is that some areas that currently support snowshoe hare populations may experience vegetation type conversion that may not support snowshoe hares. The majority of the experts predicted the persistence of a viable lynx population in the unit by 2100, but further discussion revealed uncertainty about persistence in the unit, and genetic connectivity across ski areas in the unit.

Table 4, below, summarizes factors thought likely to influence the future resiliency of lynx populations in each geographic unit.

Table 4. Predicted ~~F~~future (2050 to 2100) resiliency of individual units of the Canada lynx DPS

Lynx population	Lynx expert probability of	Key evidence	Uncertainties

Comment [MJM57]: What do WE conclude and why?

Comment [MJM58]: What do WE conclude and why?

Comment [MJM59]: Is this our thought or the experts'?

Comment [MJM60]: To he point of retracting he prediction? Need to explain he magnitude of the uncertainty.

Comment [MJM61]: By whom? The experts or us? The ti le of the table needs to make this clear.

Comment [MJM62]: See above comment. Need to make it clear if this represents our hinking or the experts' hinking.

	persistence		
Unit 1 Maine	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	• 50% decline in habitat expected by 2032, habitat will occur in south edge of range • Slight recovery of habitat by end of century depending on forestry trends • Continued demographic and genetic connectivity to southern Quebec, New Brunswick populations • Climate models predict deteriorating snow quality, depth and duration below thresholds for lynx; more severe than other units • Little elevation refugia	• Future forest management trends and habitat conditions on private forest lands in Maine and Canada • Future shifts in land ownership, forest products markets, and development • Extent and pace of deteriorating snow conditions • Response of hares (pelage mismatch), bobcat and fisher to changing snow regime • Extent and pace of loss of spruce-fir • Future trends in hare populations • Disease and parasites in lynx • Effects of lynx trapping in Quebec
Unit 2 Minnesota	2050 median 80% (range 35 to 100%) 2100 median 35% (range 0 to 100%)	• Smaller population could be susceptible to stochastic effects • Habitat conditions on national forests will remain stable or improve if managed for softwoods • Continued demographic and genetic connectivity to southern Ontario populations • Climate models predict deteriorating snow quality, depth and duration below thresholds for lynx • Little elevation gradient: lake-effect snow may retain refugia to 2050 but not 2100	• Future forest management trends and habitat conditions on private forest lands in Minnesota and Ontario • Extent and pace of deteriorating snow conditions • Response of bobcat and fisher to changing snow regime • Rate of decline of spruce-fir • Future trends in hare populations • Disease and parasites in lynx
Unit 3 Northwestern Montana	2050 median 90% (range 40 to 100%) 2100 median ~78% (range 10 to 100%)	• Some habitat loss from increased wildfire, otherwise habitat will remain stable with USFS management • Continued demographic and genetic connectivity to southern British Columbia populations • Potential high elevation buffer against climate change • Recent loss of small sub-metapopulation in Garnet Range • Increasing fire frequency	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks • Extent and pace of deteriorating snow conditions • Response of bobcat, pumas, coyotes to changing snow regime • Extent and pace of elevational migration of spruce-fir • Mismatch in elevation between appropriate snow regime for lynx and spruce-fir • Future trends in hare populations
Unit 4 North-central Washington	2050 median 70% (range 10 to 100%)	• Habitat and population low because of recent fires; could be susceptible to stochastic effects • Continued demographic and genetic	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks

	2100 median ~38% (range 0 to 90%)	connectivity to southern British Columbia populations ● Elevation is not sufficient to provide long-term refugia from deteriorating snow quality, depth, and dura ion	● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations
Unit 5 Greater Yellowstone	2050 median 35% (range 0 to 90%) 2100 median 15% (range 0 to 90%)	● Habitat loss from 1980s wildfire, otherwise habitat will remain stable with USFS and NPS management ● No connectivity with Canada populations; little immigration from DPS populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Low quality habitat; dry; low hare populations ● Smaller population could be susceptible to stochastic effects	● Will habitat support adequate landscape hare densities to support lynx? ● Extent to which GYA remains demographically isolated from other DPS populations; immigration from Colorado population ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations ● Extent to which high elevation may provide climate and snow refugia ● Extent to which area will be repopulated by the north and/or the south
Unit 6 Western Colorado	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	● Habitat loss from increased wildfire and insect outbreaks, otherwise habitat will remain stable with USFS management ● Isolation from other lynx populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Uncertainty about stability of recently-reintroduced lynx population	● Demographic and genetic effects of isolated population ● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of future insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future trends in hare populations

5.2 Future Conditions - Detailed Descriptions by Geographic Unit

5.2.1 Unit 1 - Northern Maine

Expert Projections of Future Lynx Status

Most experts indicated an initially high and subsequently declining probability of persistence of resident lynx in Maine through the end of the century, with uncertainty (range between lowest and highest probabilities) also increasing over time (Lynx SSA Team 2016, pp. 33-36 and Fig. XX below). Climate change was an overriding near- and long-term stressor.

Increased winter precipitation in the form of rain, reduced snow depth, and reduced snow durations were discussed. Changes in snow conditions will favor bobcats and fisher (a predator of lynx that is limited by deep snow). Experts believed that the effects of climate change would continue to increase as a stressor by mid- to the end of the century (2050, 2100). Snow conditions would continue to deteriorate (especially in the northern Maine unit compared to other areas in the DPS) resulting in increased competition with bobcats and predation by fisher. Climate-induced loss of spruce-fir forest will occur slowly, and an increase in northern hardwood composition of the forest is already occurring. Loss of spruce-fir could be accelerated by forest disturbance (budworm outbreak, forest management affecting large acreages of lynx habitat annually).

Experts expressed a number of near-term stressors (in the next 15 years) related to forest management in northern Maine. Land management objectives were uncertain because of changes in private forest land ownership. Changes in forestry management because of the Maine Forest Practices Act (shift to partial harvesting, increasing acreage harvest, habitat shifting to south) would result in increased fragmentation and declining lynx and snowshoe hare habitat (succession of previous clearcuts from young, dense regenerating stands to mature stands less conducive to high hare densities).

There was uncertainty concerning the severity and response by new landowners to the next spruce budworm outbreak. Experts were concerned that investment landowners would not respond to the pending spruce budworm outbreak like they did in the 1970s (extensive clearcuts, herbicide application). Experts also acknowledged concerns about the effects of the current clearcuts aging past conditions that support hares and lynx.

Hare populations have declined by about half across all stand types (and in adjacent Quebec) since 2006 and apparently have not rebounded. In response, lynx initially had lower reproduction (lower proportion of females breeding, slightly lower litter sizes), but this has not affected home range sizes. Lower landscape hare densities are likely to support lower lynx populations. It is uncertain how hare numbers will cycle or fluctuate in the future.

Comment [MJM63]: See earlier comment. Need to explain what we think about he experts' opinions and heir rationale and draw our own conclusions – and own those conclusions. Where do we do this?

Comment [MJM64]: To avoid confusion with lis ing status (i.e., E/T), refer to "population status" or "persistence."

Comment [MJM65]: Didn't hey all indicate his? Can't this be said of every species on earth?

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of spruce-fir, and bobcat competition are likely to reduce the probability of lynx persistence in this unit. Modeling of current lynx habitat and future habitat trends was more advanced for the Northern Maine Unit than other units. Models indicate that aging of past clearcuts and changes in forest practices to partial harvesting will diminish the current lynx habitat by half in coming decades. Experts and the core team expressed uncertainty about the severity of a pending spruce budworm outbreak, forestry response by investment company landowners, and how this will affect future lynx habitat. More is known about long-term trends in snowshoe hare populations in this unit than others. Hares seem to have declined by half since about 2006 and have remained low. Experts and the core team were uncertain about whether hare numbers would rebound or remain at this lower level, but lower hare densities are affecting demographics (especially percentage of females breeding), which could contribute to population declines. Taking all of these factors into consideration, the experts projected the mean probability of persistence to the years 2025 was greater than 95 percent, to 2050 was about 80 percent (range from 20 to 100 percent), and to 2100 was about 50 percent (range from 0 to 100%)(Lynx SSA Team 2016, pp. 33-34, Fig. 8). The USFWS lynx core team generally agreed with this prognosis with the exception that some were less optimistic about the persistence of this population, especially after reviewing the literature pertaining to climate change in this region.

Comment [MJM66]: These ranges encompass the full range of responses. For the other units, hese ranges encompass just he "most likely" points. Why the difference for the Maine unit?

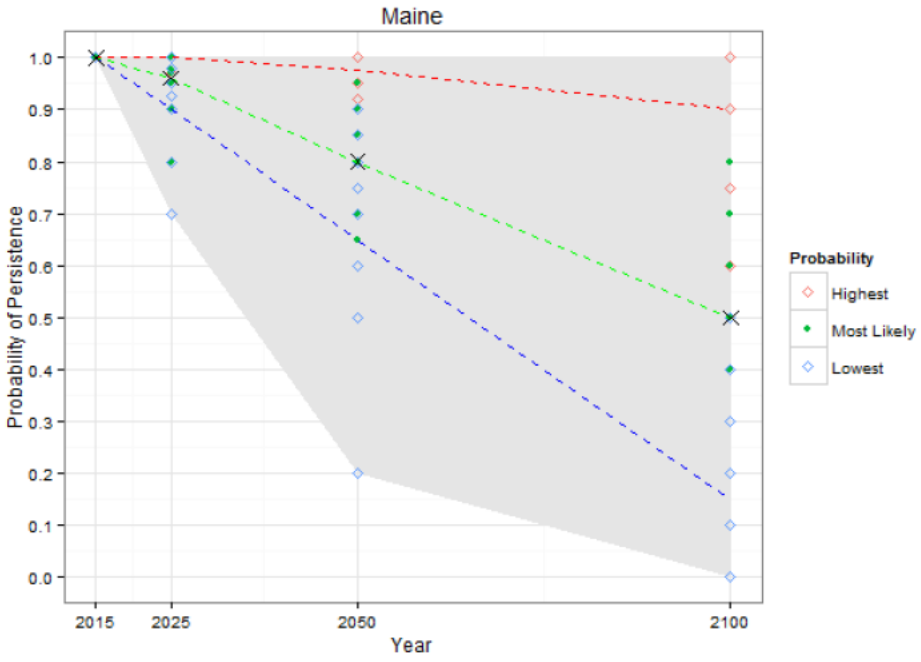


Figure 8. Lynx expert estimates of the probability that the Northern Maine Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Note: In Figure 8, above, and similar figures for the other geographic units, below, points for each of the 10 expert responses, for each of the three probability-of-persistence levels, i.e., highest, most likely, and lowest probabilities of persistence, are represented by the hollow red, filled green, and hollow blue points respectively. The black x mark is the median of the most likely responses across the experts in each response year. The red, green, and blue dashed lines connect the median of the highest, most likely, and lowest probability of persistence responses across the experts in each response year. The edges of the grey area were defined by the extreme responses, i.e., the range from the largest of the highest probability of persistence responses to the smallest of the lowest probability of persistence responses. The median lines and grey area are provided as a summarizing visualization to aid comprehension of the experts' responses and their range, and should not be viewed as a substitute for individual responses or presented outside the context of the accompanying discussion.

Service Evaluation of Factors Influencing Future Conditions

Comment [MJM67]: Where do we explain whether we agree or disagree with the experts' opinions and why? The "Service evaluation" for each unit seems to be independent of he discussions about the preceding "Expert Projections" for each unit I was expecting this explanation to be in he Service evaluations.

Regulatory Mechanisms - In response to public concern about widespread clearcutting in northern Maine, in 1989 the Maine Legislature passed the Maine Forest Practices Act (MFPA). The MFPA regulates maximum size of clearcuts (250 acres), separation zones between clearcuts, harvest plans, and notification to the Maine Forest Service. Clearcuts are not banned, but require varying levels of state permits depending on their size. As a result, the number and acreage of clearcuts completed annually has declined substantially and have been replaced by various forms of partial harvesting (Sader *et al.* 2003, p. 349-350, McWilliams *et al.* 2003, p. 35). In the first decade following passage of the MFPA, the percentage of acreage clearcut in Maine annually declined from 40 percent to 4 percent (Simons 2009, pp. 45-46). The average size of clearcuts has been reduced from >125 acres (Maine Forest Service 1995) to <25 acres (Maine Forest Service 2003, 2005, 2007). Currently, partial harvesting comprises about 94 percent of acres cut annually in Maine (Simons 2009, p. 50). The total volume harvested, however, changed relatively little. The partial harvest that replaced clearcuts include a variety of silvicultural treatments, including both even-aged (e.g., shelterwood) and uneven-aged (e.g., selection) management that result in a wide range of residual stand conditions (Robinson 2006), which have important implications for lynx conservation. Foremost, snowshoe hare densities in partially harvested forests are on average about 50 percent lower (but range from 20 to 90 percent lower) than in regenerating conifer stands created by clearcutting (Robinson 2006, entire; Scott 2009, p. 109, Simons 2009 p. 83), thus reducing landscape hare density and presenting a challenge for future lynx conservation (Simons 2009, pp. 206, 209, 217; Simons-Legaard *et al.* 2016, p. 7-8; Simons-Legaard 2016, entire).

To harvest the same volume of wood annually, landowners must partial harvest many more acres than they would under former clearcutting silvicultural systems. The acres of forest harvested annually in Maine have increased from about 250,000 acres pre-MFPA to 550,000 acres post-MFPA (McWilliams *et al.* 2003, p. 35). Currently, 27 years after implementing the

MFPA, much of the 10 million-acre northern Maine landscape has been influenced by partial harvesting. Extensive partial harvesting and aging of the spruce budworm-era clearcuts will reduce landscape hare densities (Simons-Legaard *et al.* 2016, 9-10). If the current landowners continue to harvest using similar methods at and similar rates, habitat for lynx will diminish by about 50 percent by 2030 (Simons-Legaard 2016, pp. 9-10). After 2030, projected outcomes for lynx habitat become more uncertain and depend on assumptions about habitat definitions and harvest rates. Lynx in Maine selected for regenerating, conifer-dominated forest (>75 percent conifer, Vashon *et al.* 2008, pp. 1490, 1492-1494). If one defines lynx habitat as stands having greater than 75 percent spruce-fir, then habitat will decline by about 50 percent by 2030 and remain at about at this level through 2060 (Simons-Legaard 2016, pp. 9,16).

These projections do not consider the next outbreak of spruce budworm. After being low for the last 20 years, spruce budworm numbers are again building toward epidemic levels in Maine, southern Quebec, and northern New Brunswick. Significant defoliation in Maine is expected to begin between 2018 and 2021 (Wagner *et al.* 2014). Although Maine research has clearly demonstrated that landowner response to the last outbreak resulted in unintended, positive benefits for lynx from one to three decades later, our ability to project what effects the next outbreak will have on lynx habitat is still limited. Land ownership has changed dramatically since the last outbreak. To reduce risk from spruce budworm, some financial investment owners may cut younger spruce-fir stands that still support elevated hare populations. Some may be less inclined to intensively manage for spruce-fir. It is unlikely that current landowners will use widespread use of pesticides to control spruce budworm and herbicides to promote spruce-fir regeneration after stands are defoliated. The MFPA may serve as an additional constraint on motivation to clearcut infested stands, even with recently-enacted changes intended to reduce the regulatory burden for landowners. Landowner response to the pending outbreak will have important implications for the short- and long-term persistence of lynx habitat in the northern Maine unit (Simons-Legaard 2016, pp. 16-17).

Nor do these projections consider a substantial decline in snowshoe hare densities that has occurred in Maine. Snowshoe hare density declined by 69.3 percent from a period of high hare density in 2001-2006 (average of 2.1 hares/ha in regenerating conifer) to a period of lower hare density 2007-2009 (average of 1.0 hares/ha). This decline occurred across all forest stand types and across a broad geographic area of Maine (Scott 2009 p. 36) and the adjacent Gaspe region of southern Quebec (Assells *et al.* 2007, Scott 2009, p. 41-42). Hares remained at these lower numbers through 2013 (D. Harrison, University of Maine, unpublished data). If future hare populations remain low, then Maine habitats will have a lower capacity for supporting lynx.

Climate Change - The northern Maine unit is more vulnerable to snowpack loss because of the lack of elevational refugia (Siren *in* Lynx SSA Team 2016, pp. 15 and experts p. 37) and changes in snow conditions could further restrict their range (Hoving 2002, Hoving *et al.* 2005, Carroll 2007). Wildlife experts in Maine ranked lynx as highly vulnerable to climate change (>66 percent loss in species range/population and extirpation within 50 to 100 years) (Whitman *et al.* 2013, p. 19, 74). Similarly, Carroll (2007, entire) modeled Maine lynx population assuming non-cycling hare populations and snow conditions expected under intermediate to high emissions

Comment [MJM68]: Lynx in Maine, or lynx everywhere?

climate models (Kiehl and Gent 2004, entire). He predicted a 59 percent decline in the lynx population (the non-cycling hare population model) by mid-century because of climate change alone. Maine lacks elevational refugia for lynx under reduced snow scenarios (Carroll 2007, p. 1102), except for the mountains in western Maine where snow refugia may only persist as very small, isolated “sky islands” that would be unlikely to support lynx.

Climate change is affecting the Northeast, and the rate of change is faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46^{o} C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Northeast climate models predict average winter temperature increasing 2.0^{o}C (low emission) to 2.9^{o}C (high emission) by mid-century and 3.1^{o}C (low emissions) to 5.3^{o}C (high emissions) by late century (Notaro *et al.* 2014). Largest increases in temperature are expected in northern Maine (A. Siren, Workshop Notes 2016, Rawlins *et al.* 2012) where temperatures may increase 4.5 to 5.0^{o} F by 2050 (Fernandez *et al.* 2015, p. 3). In response to climate change, interest in wind development has escalated in northern and western Maine increasing threats to high elevation and potential spruce-fir refugia (Whitman *et al.* 2013). Climate conditions are currently at or falling below threshold values needed to support lynx in Maine.

If future trends in increasing temperature and decreasing snow occur, then lynx are unlikely to persist in Maine. Gonzales *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007) and predicted loss of forest and snow conditions able to support lynx in Maine by the end of the century. Although there are uncertainties about future climate warming, lynx populations in Maine are expected to recede northward and decline substantially this century (Vashon *et al.* (2012, p. 60).

Snow Duration. The current average snow duration in Maine is at or below the 4-month snow persistence thresholds believed needed to support lynx (section 4.1.1, Gonzales *et al.* 2007) and is projected to decline. Snow duration is projected to continue to deteriorate. Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another ~~two~~2 weeks in Maine by mid-century (Fernandez *et al.* 2015). Snow duration is expected to diminish by 25 percent (low emissions) to 50 percent (high emissions) from current conditions by the end of the century (Hayhoe *et al.* 2006). Similarly, Notaro *et al.* (2014) projected an average decrease of 28 days (low emission) to 47 days of snow cover (high emissions) by the end of the century.

Snow Depth. The current average snow depth in northern Maine is at or below the 270 cm/yr. (106 in/yr) thresholds believed needed to support lynx (section 4.1.1; Hoving *et al.* 2005) and is expected to decline. By the end of the century, large areas of the Northeast will experience 15-percent (low emission) to 25-percent (high emissions) reduced snowfall (Ning and Bradley 2015). Similarly, by the end of the century Notaro *et al.* (2014) projected average snow declines in the North Atlantic Landscape Conservation Cooperative of 59 cm (31 percent) (low

emissions) to 92 cm (48 percent) (high emissions) because a higher proportion of winter precipitation will fall in the form of rain rather than snow. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015).

Snow Quality. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015). Snow density and compaction (caused by wet, heavy snow or rain on snow events in winter) will continue to increase in the region in the future (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006, Karl *et al.* 1993).

Loss of Boreal Forest. Climate change is projected to cause a northward contraction of spruce-fir forest in the Northeast with potential negative consequences for both lynx and snowshoe hares (Gonzales *et al.* 2007, entire). Spruce-fir forest is expected to decline substantially in Maine and the Northeast (Ollinger *et al.* 2007 Beckage *et al.* 2008, Tang and Beckage 2010, Whitman *et al.* 2010, p. 12, Jacobson *et al.* 2009, p. 27) or disappear (Iverson and Prasad 2001, pp. 192-193, Prasad *et al.* 2007) because of climate change. Climate change is anticipated to increasingly fragment the boreal forest in northern New England (Iverson *et al.* 2008, Ollinger *et al.* 2008, Whitman *et al.* 2013). Lynx habitat will decline as boreal forest diminishes (Simons 2009). Even under the lowest emissions scenarios, spruce-fir forest would be greatly reduced by 2100 (Williams and Liebhold 1997, Prasad *et al.* 2007), although some spruce-fir may persist at highest elevations (Tang and Beckage 2010) and along the eastern coast (Jacobson *et al.* 2009) where cooler conditions will prevail.

The spruce-fir forest type has come and gone from New England during the post-glacial period. It nearly disappeared from the Northeast during interglacial warming period 1000 years ago, then moved south into New England only in the past few centuries during the “Little Ice Age” (Schauffler and Jacobson 2002, DeHayes *et al.* 2000). Because of its sensitivity to climate and mobile nature, Iverson *et al.* (2008, p. 403) predicted a significant decline (low emissions) or the disappearance (high emissions) of the spruce-fir forest type in northern Maine in response to climate change.

Spruce (red, black, white) and balsam fir are the most important boreal forest conifer tree species in the Northeast and will be affected by climate change in different ways. Mechanisms of injury to spruce-fir include winter injury from freeze-thaw cycles, spring drought (because of reduced snowpack), and reduced seed germination (Perfect *et al.* 1987, Auclair *et al.* 2010). Thus, the range of spruce-fir is limited by summer heat and drought. Mohan *et al.* 2009 projected that suitable area for balsam fir would decline by 80 percent in 2100 under an average to high emissions scenario. In contrast, Ollinger *et al.* (2008) projected increasing growth rates for balsam fir and red spruce to mid-century, after which they would decline.

The timescale of the spruce-fir decline in the Northeast is difficult to predict because of the many variables that influence shifting of the forest species composition (emissions scenarios, the long lifespan of trees, slowness of tree dispersal, frequency of disturbance, competition from advancing hardwoods and invasive tree species, complex interactions with moisture, and synergistic effects with other pollutants). Arguments in favor of an accelerated decline include evidence that spruce-fir is already in decline (Seymour 1992, Simons 2009) and is being replaced in Maine by northern hardwoods (oak, pine, red maple). The decline of the spruce-fir forest type is accelerated by forest disturbances. A pending spruce budworm outbreak and frequent disturbance from forest management could accelerate conversion to northern hardwoods in northern Maine and eastern Canada (Flannigan *et al.* 2001, Gauthier *et al.* 2015). Other climate-related forest disturbances (forest pests, diseases) could further accelerate conversion to northern hardwoods (Iverson *et al.* 2008, p. 404).

In contrast, some authors note that trees migrate slowly and are long-lived. Therefore, a time lag may occur in shifting forest composition from spruce-fir to northern hardwoods (Mohan *et al.* 2009, Zhu *et al.* 2012). Some northern Maine industrial forest landowners could "adapt" to climate change by intentionally favoring spruce-fir (e.g., by plantations and use of herbicides). McWilliams *et al.* 2005 (p. 8) noted that balsam fir increased in Maine's forest inventory in the 2000s. Forest models projected increases in spruce-fir biomass over the next century because of partial harvesting and periodic budworm outbreaks, but did not take climate change into consideration (Simons-Legaard *et al.* 2013).

Finally, there is uncertainty concerning the influence of climate change on balsam fir, a short-lived, shade-tolerant, conifer that dominates much of the understory in the Acadian forest and is an important component of lynx habitat in the Northern Maine Unit. Climate change will influence precipitation and temperature, forest management strategies, and forest disturbance (fire frequency and spruce budworm), all of which will interact in complex ways to influence the spruce-fir forest at the southern edge of its range. Carter (1996), Iverson *et al.* (1999), and Goldblum and Rigg (2005) documented balsam fir growth rates and growth potential would decline under likely climate warming scenarios (~4 to 5 F degree temperature increase by the end of the century and reduced snow conditions). Some have projected the extirpation of spruce-fir forest types in the Great Lakes States (Scheller and Mladenoff 2005) and New England (Iverson and Prasad 2000). In contrast, balsam fir has prolific seed production following forest disturbance such as harvesting (Seymour 1992), and has proliferated under the current climate and forest management regime dominated by partial harvesting (Olson *et al.* 2013, entire). Balsam fir is a relatively short-lived tree (~100 years), and is unlikely to persist long if climate change affects seed and germinations rates. Given, anticipated climate changes, especially early snow melt and low spring precipitation, fir may increase for the next few decades but is unlikely to regenerate in a the future Maine forest (E. Simons-Legaard, University of Maine, pers. comm. May 31, 2015).

Vegetation Management - Habitat suitable for lynx is expected to decline in the future (see Regulatory Mechanisms section above). By 2020, all of the extensive areas that were clearcut in the 1970s and 1980s will be greater than 35 years of age and no longer support high hare

densities. For the foreseeable future, partial harvesting will continue as the primary means of forest management. Although partially harvested forests with well-developed understory structure may provide foraging opportunities via increased prey access (Fuller *et al.* 2007), snowshoe hare densities are approximately 50 percent less in landscapes dominated by partially harvested stands (Robinson 2006, entire; Fuller and Harrison 2010). Thus changing forest management practices will continue to reduce landscape hare density below levels that can support lynx.

Sources of uncertainty concerning future habitat conditions in northern Maine include changes in forest policy, timber harvesting methods, changing timberland ownership, response to budworm outbreaks, and timber markets - all of which have occurred in the recent past and will undoubtedly shape forest management in the future (Simons-Legaard *et al.* 2016, p. 8). Currently, the landscape is owned primarily by financial investors who may be less inclined to intensively manage for spruce and fir after the next outbreak of the spruce budworm (Wagner *et al.* 2014).

The dramatic shift from clearcutting to partial harvesting presents a challenge for lynx conservation in this unit for the next several decades. Lynx, habitat is expected to peak and remain stable through about 2020 (Simons 2009, Simons-Legaard *et al.* 2016 p. 6). After 2020, aging of the former clearcuts and extensive partial harvesting are projected to result in a 50 to 65 percent decline in lynx habitat by 2032. Lynx habitat will decline from about 9.5 percent of the landscape (current condition) to about 4.5 percent of the landscape (Simons-Legaard 2016). By 2032, the Northern Maine Unit may support less than half the lynx population as it does today (Simons 2009, p. 209, 217).

In the future, lynx habitat will be fragmented into smaller, isolated parcels, and will shift southward into areas occupied by bobcats and fishers where snow conditions are unlikely to support lynx (Simons 2009, Simons-Legaard *et al.* 2016, Simons-Legaard 2016). By 2022, the number of patches of high quality hare habitat will increase by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6). The proximity index of high quality habitat patches will decline by 78 percent within lynx home ranges. Although lynx habitat is peaking, fragmentation is diminishing its ability to support lynx (Simons-Legaard *et al.* 2016).

Beyond 2030 assumptions concerning future climate change, land ownership, and harvest rates introduce greater uncertainty. The most optimistic forest management models (greatest harvest rates, no climate change, no spruce budworm) project that lynx habitat will decline over the next few decades then gradually increase to about 10 percent of the landscape by 2060. The most most pessimistic models (lowest harvest rates, no climate change, no spruce budworm) project about 5 percent of northern Maine will have high quality hare habitat (Simons-Legaard 2016, entire), although the habitat will be much more fragmented and smaller patch size (Simons-Legaard *et al.* 2016).

Softwood plantations could offset losses in spruce-fir and become a form of adaptation to climate change. Jack pine plantations are extensive in adjacent New Brunswick (Etheridge *et al.* 2005, p. 1966). A forest company that has planted extensive spruce plantations in New Brunswick and recently purchased nearly 1 million acres of forestland in northern Maine where they are doing the same. Spruce plantations are becoming more common on this ownership in Maine, but not others. Stand structure and intensive management of plantations are highly variable (e.g., pruning, thinning, herbicide treatments), thus hare density and use by lynx vary (Roy *et al.*) Hares can achieved higher densities in plantations depending on the amount of lateral cover, but for shorter periods of time; ~10 to 17 years after cutting and planting in New Brunswick (Parker 1984, p. 163) and 15 to 25 years in Quebec (Roy *et al.* 2010, p. 585). This is in contrast to ~15 to 35 years in naturally regenerating spruce-fir stands after harvest (Simons-Legaard *et al.* 2016, p. 4). The future of plantations in the northern Maine unit is uncertain. Most investment landowners have short-term investment horizons and are unlikely to invest in plantations.

Natural stand-replacing disturbances are rare and infrequent and, other than spruce budworm outbreaks, are unlikely to significantly affect future habitat conditions (Hoving *et al.* 2004). A spruce budworm outbreak is projected to reach epidemic proportions in 2018 to 2021. The epidemic has already affected 10 million acres of spruce-fir in southern Quebec, immediately north of Maine (Wagner *et al.* 2014, entire). The last outbreak in the 1970s and 1980s killed millions of acres of spruce and fir forests in the northern Maine unit. Maine's 5.8 million acres of spruce-fir stands across the state are at risk of some level of defoliation. The intensity of the next outbreak is uncertain, although some project a weaker outbreak because spruce and fir trees are younger and less susceptible and there is a higher hardwood component in northern Maine forests (Wagner *et al.* 2014, p. 21-27). A typical outbreak lasts for a decade.

Forest management strategies for addressing the coming outbreak vary and include applying insecticides (although land area sprayed is expected to be small compared to the previous outbreak), pre-emptive cutting of mature spruce-fir before defoliation, stop precommercial and commercial thinning, and salvaging dead and diseased trees (Wagner *et al.* 2014, pp. 5-6). An aggressive forest management response (or not) will greatly affect future outcomes for lynx habitat (see section 5.2.1). The next budworm outbreak and subsequent forestry response is a disturbance agent that may accelerate changes in forest composition influenced by climate change, especially toward increased northern hardwood and reduced spruce-fir. The nature of landownership is greatly changed from the 1970s and 1980s, and landowner response is expected to be diverse depending on their objectives and investment horizons. The pending budworm outbreak cast additional uncertainty on the status of lynx habitat beyond 2030.

Climate change, forest management and budworm outbreaks will interact to influence the future trajectory of spruce-fir forest in Maine. All three variables have yet to be modeled simultaneously (K. Legaard, UMaine, personal communication). Assuming current forest management trends persist to the end of the century, spruce-fir dominated forest is expected to continue to decline (Legaard *et al.* 2013, entire). The combination of budworm-induced mortality and salvage harvesting will have a negative effect on spruce-fir (Legaard *et al.* 2013, entire).

However, after a budworm outbreak the biomass and area of mixed-hardwood/softwood forest would be expected to increase through this century primarily because of regenerating balsam fir (see discussion above) (Legaard *et al.* 2013). Mixed forests having a high hardwood component are not believed to support high hare densities (Scott 2009, p. 109) or be preferred by lynx (Vashon *et al.* 2008, pp. 1492-1493). It is uncertain whether lynx can adapt to lower landscape hare densities associated with mixed hardwood-softwood forest. They may persist, but at lower densities as they currently do in the western units of the DPS. However, the probability of persistence is further diminished by deteriorating snow conditions and increased populations of bobcats and other competitors.

Fire Management - Susceptibility of the northern Maine unit to fire may be enhanced by a severe spruce budworm outbreak because of the amount of dead and dying spruce-fir (Stocks 1987), although there were no large fires after the last outbreak. Fire risk is currently very low in this unit and a continuous decrease in fire frequency is predicted with climate change in eastern Canada because of increased precipitation and decreased drought (Bergeron and Flannigan 1995, Flannigan *et al.* 1998). Climate is expected to become more variable during the next century (Gregory & Mitchell 1995; Gregory *et al.* 1997), which could create fire conditions in unusually dry years (Flannigan *et al.* 1998, p. 475). Maine's policy is to immediately suppress wildfire, thus large, stand-replacing fires are expected to be infrequent in this region. Notable large fires in Maine include a 3 million-acre fire in 1825 and a 200,000-acre fire in 1947.

Habitat Fragmentation - The future of the 10 million-acre, sparsely populated "North Woods" of Maine is highly uncertain and has been the subject of intense public debate (Baldwin *et al.* 2007). Land use and zoning in the state's "unorganized townships" are the responsibility of the Land Use Planning Commission (LUPC) in the Maine Department of Conservation. The LUPC revised its Comprehensive Land Use Plan (De2010), and described principal values in guiding future land management decisions: maintaining working forests, provide for traditional recreational opportunities, protect high-value natural resources, and encourage long-term conservation. The North Woods has long been considered a public resource or "commons," even though privately owned (Judd 2007, p. 9). This land was traditionally owned by a few large timber companies, but since the 1980s there has been rapid turnover in ownership largely by investments companies and subdivision of large parcels (Hagan *et al.* 2005). Financial investors, such as REITS and TIMOs focus on maximizing the asset value of timberlands and are increasingly likely to seek revenue from non-timber resources if they will generate a higher return. These new owners operate over relatively short time horizons (e.g., 5 to 15 years) and are willing to consider multiple means of monetizing their asset, including development and real estate sales (Legaard 2013, entire). If left unchecked, these pressures may continue to promote dispersed residential development throughout this region. Parcelization and subdivision has increased, particularly in the southern third of the jurisdiction (Maine Department of Conservation 2010, p. 72-73). The LUPC has limited ability to address stressors on Maine's North Woods, including resale and subdivision trend. This trend is likely to continue into the foreseeable future and will make management of large, forested landscapes for Canada lynx even more difficult.

Historically, development has stayed mostly on the edges of the North Woods jurisdiction with exception of scattered seasonal dwellings and sporting camps in the interior, but this could change in the future. Between 1971 and 2005, the LUPC permitted 8,136 new dwellings in unorganized townships — an increase of 66 percent in the number of residences during this time period (Maine Department of Conservation 2010, p.80). Between 1971 and 2005, the LUPC issued 1,353 development permits for new uses scattered throughout the unorganized townships (Maine Department of Conservation 2010, pp. 97-99); most (42 percent) being recreational facilities (boat launches, campsites, gatehouses, recreational lodges). Most development has occurred in areas that abut organized communities and near public roads. Within the interior most development has occurred on long lakeshores and waterfront. However, the amount of hillside and ridge development is growing and this trend is likely to continue (Maine Department of Conservation 2010, p. 136), which will further fragment lynx habitat.

We have an incomplete understanding of the effects of outdoor recreation on lynx and their habitat (ILBT 2013, p. 80). Future trends in outdoor recreation in northern Maine are also uncertain (Vail 2007, entire). A portion of the North Maine Woods is a gated road system that encompasses about 3.5 million acres. Visitation by outdoor recreationists is currently about 175,000 per year and declining. Likewise, visitors to Baxter State Park and the Allagash Wilderness Waterway have declined (Vail 2007, p. 107). Aside from a vigorous discussion of a proposed national park or monument, national heritage area, or a master tourism plan for the area (Vail 2007, pp. 112-113), there is likely to be stagnant or declining participation in traditional outdoor recreational activities in the future (Vail 2007, p. 107). Snowmobiling may be an exception because of declining snow (see climate change section). The effects of new or expanded downhill ski development on fragmentation of lynx habitat are expected to be minimal. Three alpine ski resorts occur within the unit on the southern margin of lynx habitat: Saddleback Mountain Ski Area in Sandy River Plantation near Rangeley, Sugarloaf Mountain Ski Area in Carrabassett Valley, and Sunday River Skiway in Newry and Riley Township. Further development of ski areas is unlikely in the western Maine mountains. Future trends in outdoor recreation and associated effects on lynx, hares, and their habitat are uncertain in the northern Maine unit

Within the last ~~five~~5 years, two landowners developed concept plans for rezoning for large-scale development hundreds of house lots and resort development within the lynx critical habitat. One concept plan would construct 975 houses and ~~two~~2 resorts on about 3,500 acres and establish a 363,000-acre conservation easement. A second concept plan would allow development on about 1900 acres of land and establish a 14,600-~~-~~acre conservation easement. Although these developments have not been built, they may portend future trends in land use.

Energy production is emerging as a potentially significant economic factor in this unit, with grid-scale industrial wind power, biomass, biofuels, and other energy sources offering new opportunities to utilize natural resources. Wind energy resources are high within the lynx critical habitat (National Renewable Energy Laboratory 2010, http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mecitation; last accessed 5/25/2016), and wind development in the lynx critical habitat are likely to

accelerate in the foreseeable future. Mining is not a traditional land use, but a large operation is being considered at one location in the lynx critical habitat. Extraction operations for gravel (for road building) are widely scattered throughout the unit.

The lynx critical habitat is heavily roaded, particularly with forestry roads. While accurate numbers are difficult to obtain, approximately 1,500 miles of public roads and over 20,000 miles of private roads exist within unorganized areas of Maine (Maine Department of Conservation 2010). There has been discussion of an east-west limited access highway through northern Maine and extending Interstate 95 north from Houlton to Presque Isle, which, if constructed, would further fragment habitat (Maine Department of Transportation 1999, Beck *et al.* 2012, p. 38).

An increasing area of the lynx critical habitat area is likely to be placed under conservation easements that will limit future development and fragmentation of lynx habitat. Maine has the largest amount of land under easement of any state, and there are about 2 million acres of conservation easements in lynx habitat in northern Maine (Pidot 2011). Continued expansion of areas under conservation easement is uncertain and will depend on willing landowners and funding available for purchase of easements

All of development trends portend increased fragmentation of lynx habitat in the northern Maine unit. As habitat is fragmented, it will become increasingly difficult to influence landscape-scale forest management that could benefit lynx.

5.2.2 Unit 2 - Northeastern Minnesota

Expert Projections of Lynx Status

The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century (Lynx SSA Team 2016, pp. 37-38 and Figure 9, below). Near term drivers of the projected decline were reduced quality, quantity, and persistence of snow, competition from bobcats, disease (*e.g.*, lungworm, liver fluke, feline leukemia), and forest insects. Long term drivers of the projected decline were reduced the quality, quantity, and persistence of snow, competition from bobcats, loss of spruce-fir forests, wildfires, and climate change. Climate change was primarily associated with loss of boreal forest but could potentially also increase disease or insect outbreaks, and is likely to affect the amount of precipitation falling as good quality snow in the area of the state supporting lynx habitat. The connection to lynx in Ontario reduces the likelihood of local extirpation in this geographic unit, but the likelihood would increase if connectivity was compromised. Taking all factors into consideration (i.e., loss of boreal forest, competitions, disease and insect outbreaks, loss of snow), the experts projected the mean probability persistence to the year 2025 was greater than 90 percent, to 2050 was 80 percent (ranging from 60 to 90 percent), and would decline to approximately 35 percent (ranging from 10 to 60 percent) by 2100 (Lynx SSA Team 2016, pp. 37- 38).

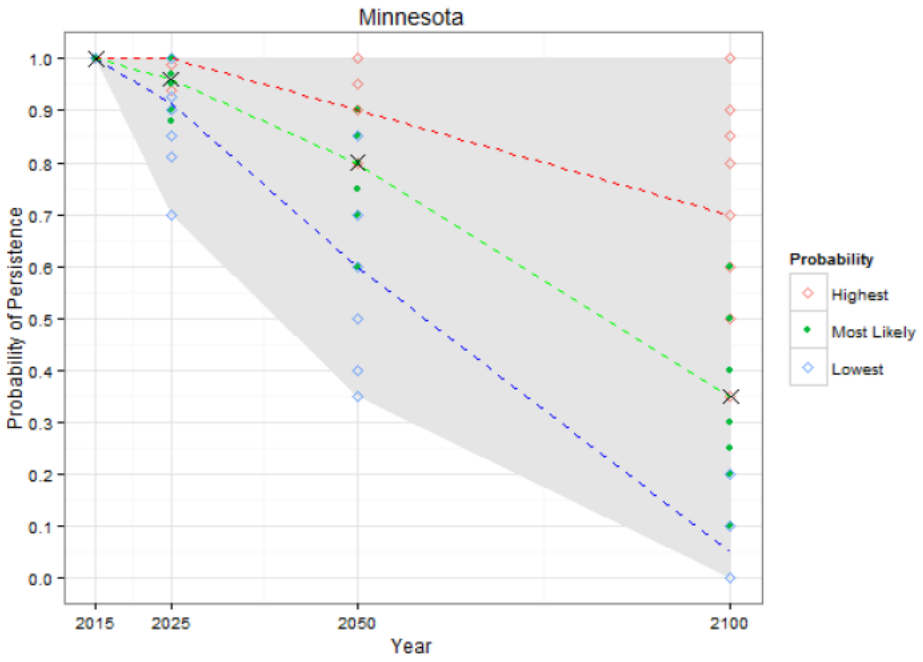


Figure 9. Lynx expert estimates of the probability that the Northeastern Minnesota Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - In Minnesota, the vast majority of lynx habitat that supports long-term persistent lynx breeding population is administered by the Superior National Forest. This area includes designated critical habitat (79 FR 54782). The SNF is currently implementing the 2004 SNF Plan (USDA 2004a), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the Superior National Forest has a long-term commitment for doing so. If the SNF continues to follow vegetation and wildland fire management and other applicable recommendations under the 2000 LCAS (or the updated 2013 LCAS or subsequent updates) in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. Management of lynx and its habitat on SNF land will remain in place until the forest amends or revises ~~their~~its individual LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended Forest Plans (LPMPs).

Comment [MJM69]: See comments about establishing proper context (lynx not listed) for evalua ing future conditions.

Although outside of areas considered to be core lynx area (i.e., where lynx are persistent and are reproducing) in the Great Lakes, the Chippewa National Forest and the Chequamegon-Nicolet National Forest Forest Plans also include direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs (USDA CNF 2004, USDA CNNF 2004).

Additionally, the Minnesota Department of Natural Resources (MN DNR) manages approximately 36 percent of the lynx habitat in this unit, and private landowners make up about 16 percent of the unit. Under the Sustainable Forest Resource Act of 1995 (revised in 2014), the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2013, entire; MFRC 2014, entire) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx (MFRC 2014, pp. 4-5). It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue. Private landowners, however, do not have an official commitment to land management. We cannot say with any certainty what proportion of privately owned land will follow those guidelines into the future, because following the guidelines is voluntary.

Comment [MJM70]: But two sentences before we say we expect voluntary ac ions will continue. This makes it sound like we have no clue whether anyone will follow the guidelines. Surely we can say with some certainty that at least some minimal number of landowners will continue to follow he guidelines.

The NPS manages Voyageurs National Park, which is also within the Minnesota unit. Voyageurs National Park protects an area of 882 km^2, of which 534 km^2 (62 percent) is covered by forests and other uplands (Moen *et al.* 2012, p. 348), but does not have lynx specific direction in its management plan (NPS 2002, entire). The National Park consults with the FWS to consider the effects of any projects to lynx (NPS 2002, p. 26) and is anticipated to do so as long as the species is listed under the ESA. Lynx documented on and near Voyageurs National Park are probably transient animals (Moen *et al.* 2012, p. 348).

Approximately 1 percent of the Minnesota unit is managed by the Grand Portage Band of Chippewa, who has been actively working on lynx conservation since 2004. On-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire) and are expected to continue into the future.

In response to a 2008 court ruling, the MN DNR began to draft a plan to address incidental take of lynx that may result from otherwise legal trapping in Minnesota. This plan is still under development by the MN DNR and will be designed to reduce the likelihood of incidental take from trapping (LCAS 2013, p. 49).

Comment [MJM71]: But what do we think will happen if lynx were not listed?

Climate Change - The direct and indirect effects of climate warming are expected to affect lynx in Minnesota (Siren *in* Lynx SSA Team 2016, pp. 15 and Moen *in* Lynx SSA Team 2016, p. 19) and could further restrict their range. Since the time of listing, new information on regional climate changes and potential effects to lynx habitat has been developed (e.g., Danby & Hik 2007; Gonzalez *et al.* 2007; Knowles *et al.* 2006, Notaro *et al.* 2015), and this new information

suggests that climate change may be an issue of concern for the future conservation of lynx because lynx distribution and habitat is likely to shift upward in elevation within its currently occupied range as temperatures increase (Gonzalez *et al.* 2007, entire). Greatest stressors of climate change include diminishing snow depth, quality and duration; competition from bobcats and other carnivores, hybridization with bobcat (Schwartz *et al.* 2002); loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing forest conditions in Ontario.

Gonzales *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007, pp. 44-47) and predicted loss of forest and snow conditions able to support lynx in Minnesota by the end of the century. Notaro *et al.* (2015, pp. 1668-1669) projected changes in lake effect snowfall using downscaled climate models (Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4; Elguindi *et al.* 2011 and Giorgi *et al.* 2012 as cited in Notaro *et al.* 2015) for the Great Lakes Basin. Siren (*in* Lynx SSA Team 2016, p. 15) stated that climate models show an increase in lake effect snow in the eastern Great Lakes until 2050, with a decline later in the century, with an overall decline in the amount and duration of pack in the Midwest. Although there are uncertainties about future climate warming, lynx populations in Minnesota are expected to recede northward and decline over the next century (Lynx SSA Team 2016, pp. 37-38).

Lynx require at least ~~four~~4 months (120 days) of continuous snow coverage (Gonzales *et al.* 2007, p. 7). Snow cover days of 1 inch or greater in northern Minnesota (1959 -1979) ranged from 130-160 days, of 6 inches or greater ranged from 85 to 130 days, of 12 inches or greater ranged from 50 to 100 days, of 24 inches or greater ranged from 10 to 30 days (Kuehnast *et al.* 1982, pp. 7-9). In the future, Notaro *et al.* (2015, p. 1675) projected a general reduction in the frequency of heavy lake-effect snowstorms during the twenty-first century, with the exception of projected mid-century increases around Lake Superior when local air temperatures are expected to remain low enough for precipitation to largely fall in the form of snow. The snow season in the Great Lakes basin is likely to become substantially compressed during the twenty-first century with dramatic increases in rainfall (Notaro *et al.* 2015, pp. 1676-1678). The Minnesota unit may be more vulnerable to snowpack loss due to lack of elevational refugia (Siren *in* Lynx SSA Team 2016, p. 15).

Normal annual snowfall from 1981-2010 in northeastern Minnesota ranged from 140 to 241 cm per year (55 to 95 in/yr.) http://www.dnr.state.mn.us/climate/summaries_and_publications/normals_snow_1981_2010.html, accessed 24May2016) and is projected to decline across the Great Lakes Basin (Notaro *et al.* 2015, p. 1675). Snow quality ('fluffiness") is projected to deteriorate in the Great Lakes. Notaro *et al.* (2015, pp. 1671-1674) projected a dramatic decline of Great Lakes ice cover that will become confined to the northern shallow lakeshores during mid-to-late winter by the end of the century. Ultimately, this leads to increased rainfall, not snowfall, as these projected reductions in ice cover and greater dynamically induced wind fetch lead to enhanced lake evaporation and total lake-effect precipitation (Notaro *et al.* 2015, pp. 1674-1678).

Climate change is projected to cause some northward contraction of boreal conifer forest in Minnesota (Gonzales *et al.* 2007, p. 16, 18) with some potential loss of habitat at the southern portion of lynx habitat in the state (Gonzales *et al.* p. 2007, p. 19). According to Frelich (*in* Lynx SSA 2016, p. 14) Minnesota is likely to lose boreal biome, potentially within the next 60 to 70 years, with unmitigated climate change. According to Gonzales *et al.* (2007, p. 8), the Superior National Forest is a potential refugia for lynx in the lower 48 states, however, when compared to other regions.

Vegetation Management - Vegetation management conducted under the Forest Plan currently will likely continue into the future on Forest Service lands in Minnesota. These activities include timber harvest, such as thinning, clear-cutting, shelterwood, partial cut, and uneven-aged cutting; wildlife restoration projects that involve tree cutting, shearing, burning, seeding, and planting; prescribed burning for ecological purposes, hazardous fuel reduction, and site preparation; mechanical site preparation.

Vegetation, timber, and minerals management authorized under the Forest Plan has the potential to adversely affect lynx and lynx critical habitat by reducing habitat quality for denning, foraging, and dispersal; disrupting travel, resting, and foraging patterns; disturbing denning females and reducing habitat quality for lynx prey species, especially snowshoe hare. Depending on the timing, frequency, intensity, extent, amount, or other conditions, impacts may be variable among similar projects. Using the LCAS as a basis, the Forest Plan has incorporated a number of components that would reduce the risk of those impacts into the future. We expect that management direction for lynx addressing vegetation management on national forest system lands will be incorporated into the revised or amended future plans, using LCAS as a basis.

Future Forest Plan revisions will likely maintain broad direction to design and implement vegetation management projects to maintain or restore conditions for lynx foraging and denning habitat and to maintain or improve juxtaposition of required habitat types and connectivity.

Over the long term, the Forest Plan will alter vegetation patterns on the landscape. Suitable hare habitat was predicted to decrease over time with implementation of the Forest Plan, but has actually increased since 2004 (USFWS 2011, p. 51). Management activities that create unsuitable conditions for hare generally include clear-cut and seed tree harvest, and might include management-ignited fire, mechanical site preparation, salvage harvest, and shelterwood and commercially-thinned harvest, depending on unit size and remaining stand composition and structure. Suitable hare habitat is predicted to remain above the range of natural variation, which is essentially a description of conditions that existed prior to European settlement (1600 – 1900 A.D.) of the area (USDA 2004b, p. 105). Further, unsuitable habitat for lynx would vary only slightly with continued implementation of the Forest Plan and would remain distinctly below the maximum of 15 percent unsuitable in a decade prescribed in the LCAS and incorporated into the Forest Plan. Current (2010) unsuitable habitat levels are below what was predicted in the 2004 (USFWS 2011, pp. 51-52). Because suitable habitat on National Forest lands alone is

such a high percentage within LAUs and the Superior National Forest is the majority landowner within most LAUs, we expect that in the future, the Forest would not approach the LCAS maximum of 30 percent of lynx habitat on all ownerships in an unsuitable condition within an LAU at any time, which would be ensured by corresponding guidance in the Forest Plan.

Wildland Fire Management - Unlike the Maine unit, the susceptibility of the Minnesota unit to fire may be reduced by periodic spruce budworm outbreaks. Measurable defoliation due to spruce budworm has occurred in Northeastern Minnesota continuously since 1954 (MN DNR http://www.dnr.state.mn.us/fid/july2014/articles.html) and is expected to continue into the future. Modeling to evaluate the relative strength of interactions between spruce budworm outbreaks and fire disturbances in the BWCA showed that budworm disturbance can partially mitigate long-term future fire risk by periodically reducing live ladder fuel within the forest types of the BWCA but will do little to reverse the compositional trends caused in part by reduced fire rotations there (Sturtevant *et al.* 2012, pp. 1286-1292).

The Superior National Forest manages for wildfires through preventative measures such as fuels reductions, but does not manage for wildfires in the BWCAW. Natural successional changes and those associated with natural phenomena, such as wildfire or windstorms, are and are expected to continue to be the dominant force in ecosystems on the BWCAW.

Habitat Fragmentation - Ravenscroft *et al.* (2010, p. 329) considers northeastern Minnesota forest landscape as largely un-fragmented. The BWCAW remains intact and contiguous with Canada. Within the SNF, natural disturbances and vegetation management activities make up most of the annual human-caused fragmentation in actively managed portions of the Forest. These areas typically re-vegetate within ~~three~~3 to ~~five~~5 years, depending on the forest type and number and type of activities (USDA 2011, p. 119). The Forest Plan (USDA 2004a, ~~A~~appendix E) provides direction on limiting lynx habitat fragmentation, and the Forest actively consolidates habitat through land acquisitions and exchanges.

5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Expert Projections of Future Lynx Status

Because of its connectivity to lynx populations and habitats in Canada, its large geographic extent, and the relatively large number and broad distribution of resident lynx it is thought to support, future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely (Lynx SSA Team 2016, pp. 25-34). When considering the probability that this unit would continue to support resident lynx in the future, experts noted that despite projected losses of favorable forest and snow conditions, climate models project that some boreal forest will persist in this unit and that it will maintain some areas of suitable snow into the future. Experts also noted that lynx in this unit primarily occupy public lands, which are actively managed for lynx into the future. Experts also considered recent and projected future increases in wildfire frequency, size and intensity.

As for most other geographic units, all experts indicated an initially high and subsequently decreasing probability of the persistence of resident lynx in this unit, with increasing uncertainty over time, but a higher probability of persistence at all time frames than other units. All experts predicted near-term (year 2025) persistence probability >= 95%, mid-century persistence at 70% to 100% (median = 90%), and end-of-century persistence probabilities >= 50% (median = 78%) (Figure 10, below).

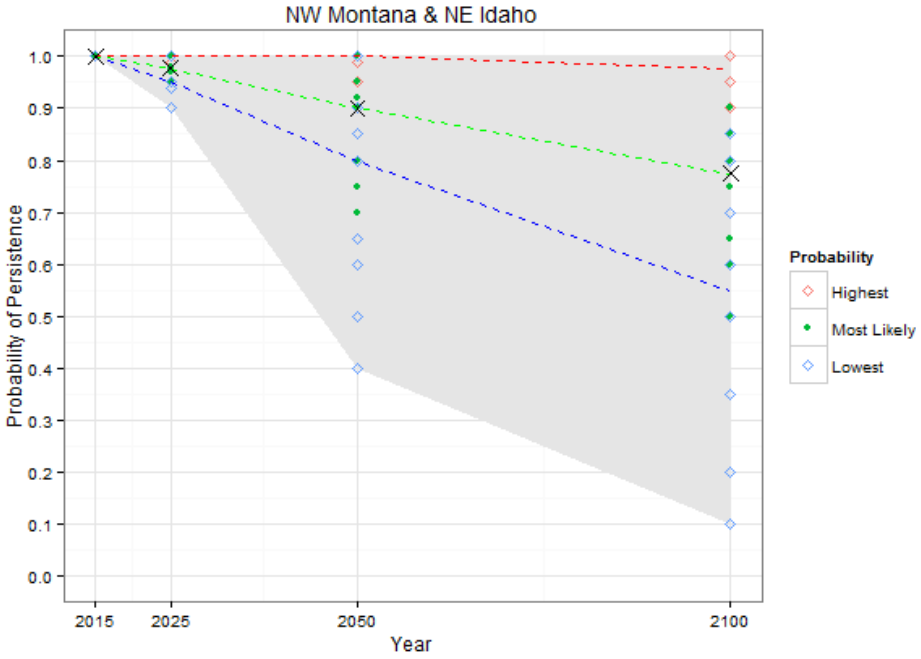


Figure 10. Lynx expert estimates of the probability that the Northwestern Montana/Northeastern Idaho Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Overall, experts assigned a higher probability of persistence in this unit compared to the other geographic units. Most lynx habitats in this unit occur on federal lands that are managed for lynx conservation, but one expert noted that little has been done to document whether lynx are responding to this management. The recent sale of large tracts of private commercial timberlands in the central part of this unit to The Nature Conservancy has increased protection for lynx via conservation easements managed for lynx. Habitats in some areas should improve in the near future as previously cut or burned areas mature into dense stands. Unlike the Maine and Minnesota geographic units (but similar to most other western units), high elevations in this unit could buffer the effects of climate change by providing for the upslope migration of lynx habitats and snow conditions that climate models predict. However, this would result in even patchier and more isolated islands of habitat in high elevation areas that would be more prone

to extirpation due to catastrophic or stochastic events. Competition from coyotes and bobcats seem to be less of a concern for this unit.

This unit has unimpeded connectivity with Canada, but some experts questioned whether this geographic unit depends on intermittent immigration of lynx from Canada, and whether the historic lynx population cycles in Canada believed to have fueled such immigration are still occurring or will into the future. There doesn't appear to be much demographic input from recent cycles. There is evidence of lynx from this unit moving north into Canada, but little evidence of demographic interactions among the three subpopulations (Purcell Mountains, Seeley Lake, and Garnet Mountains) in this unit. Experts noted that the Garnets Mountains subpopulation at the southern end of this unit may have recently become extirpated.

Discussion among experts indicated that fire was more of a concern for this area. Increased fire extent and severity or other catastrophic events and small subpopulation effects in separated mountain ranges could affect lynx persistence in the future in some parts of this unit. Fire exclusion in this area for the last 100 years likely resulted in the accumulation of fuels; however, this unit may have a reduced probability of a catastrophic fire over time because of recent changes in management and recent fires that may have reduced fuels. Out to the year 2050 and beyond, some experts felt there may be more pressure on lynx populations in this unit from continued increases in fire extent and severity. Other experts expressed a different opinion of the overall effect of fire in this unit, indicating that it may actually improve habitat over time, and that whether fires improve or degrade habitat depends on the frequency, intensity, size and spatial extent of future fires.

Experts discussed the possibility for increased precipitation and warmer temperatures in this unit because of climate change, and how this might affect lynx habitats. Boreal/subalpine forest may move up in elevation as described above; however, experts expected a shift in forest composition and diminished lynx habitat quality in future with climate change. It is unknown how much the distribution of dry ponderosa pine (non-habitat for lynx) will increase with climate change, but it is likely to happen at some level. One expert cautioned that some climate modelers estimated that vegetation will lag about 50 years behind the projected changes in temperature and precipitation. Snow levels in lower elevation areas are already decreasing in some areas, which could lead to smaller areas for lynx to use in winter in the future.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - Federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Because most (84 percent) of this geographic unit consists of ~~f~~Federal lands, the regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations in this unit. When Forest Service, Park Service, and BLM management plans are revised or amended, they require opportunities for public participation in accordance with several statutes (e.g., the National Environmental Policy Act [NEPA], National Forest Management Act [NFMA], National Parks and

Recreation Act, Federal Land Policy and Management Act [FLPMA]) (USFWS 2014 pp. 26-34, also see 3.1, above). If plan amendments or revisions may affect listed species, management agencies must consult with the Service in accordance with section 7 of the ESA. If in the future the lynx DPS is determined by the Service to be recovered and the protections of the ESA no longer necessary (i.e., if the DPS is removed from the *Federal Lists of Endangered and Threatened Wildlife and Plants*), the ESA requires the Service, in cooperation with the States, to monitor the DPS for a minimum of ~~five~~5 years to assess its ability to sustain itself without the ESA's protective measures. If, within the designated monitoring period, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future ~~f~~Federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (BLM 2004a, pp. 2-3; USFS 2007, Attachment 1, p. 2). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore the capacity of the areas that historically or recently supported resident lynx populations, including the Northwestern Montana/Northeastern Idaho Geographic Unit, to continue to do so in the future.

On non-~~f~~Federal lands (about 16 percent of this unit), as described above (sections 3.1.1 and 4.2.3, Habitat Status), recent acquisitions and conservation easements on some of the private lands in this unit will also reduce the likelihood of future adverse impacts to important lynx habitats. Similarly, the MTDNRC HCP includes a 50-year commitment to manage most (64

Comment [MJM72]: See my comment at beginning of Chapter 5 about establishing the proper context for evaluation of status. That context requires we evaluate status assuming he lynx is not currently listed. Our assessment would take into account everything that would be different if the lynx were not listed, not just Federal management.

Also, if this correct context is established, it's not appropriate or necessary to describe what will happen if we were to delist the DPS – we' will have already established a context of the lynx not being listed. We don't need to envision how the world will change as a consequence of going through the delisting process (and initiating postdelisting monitoring); we simply need to envision he world without the lynx being listed.

In envisioning the world without the lynx being listed, we can and should still assess how Federal agencies, states, landowners, etc. will act in a world where future lis ing of the lynx is a possibility. So, the prediction here that Federal management will continue to be protec ive of lynx (so as to avoid a possible future listing) is OK, but the way we get to his conclusion needs to be revised.

This kind of analysis needs to be done for all units and for all actors (Federal agencies, states, landowners, etc.) and for all consequences, not just regulatory mechanisms.

percent) State lands in this unit to conserve lynx foraging, denning, and connectivity habitats. Additionally, the Confederated Salish and Kootenai Tribe's objective to manage wildlife and habitats on the Flathead Reservation for future generations (section 3.1.2, Tribal Management, above) suggests continued management to conserve lynx habitats on Tribal lands.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will continue to support resident lynx into the future.

If the DPS ~~were to be delisted in the future~~was not listed, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Comment [MJM73]: Suggest addressing this in each unit analysis.

Comment [MJM74]: Why? Have the states expressed this reasoning as part of their operating principles? If so, cite this evidence.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.3, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 41). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but

habitat quality, quantity, distribution, and connectivity are expected to decline, likely compromising this unit's continued ability to support resident lynx populations.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, and to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on future lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of these landscapes to continue supporting resident lynx may be compromised, and lynx populations may be unable to persist until favorable vegetation conditions return. This is especially true where habitats and populations are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much if not all of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced (as is suspected) by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will reduce this geographic unit's ability to continue to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx populations in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will reduce future habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal and most non-federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.3, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted

there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.3, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although this increased wildfire activity does not appear to have diminished this unit's current ability to support resident lynx, it could do so in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support a resident lynx population until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.3, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy

development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – As described above and in section 4.2.3, maintaining connectivity between this geographic unit and lynx populations in Canada is thought to be important, although it is uncertain if or to what degree immigration of lynx from Canada is essential to the persistence of lynx in this unit. A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected.

Although the extent to which this factor may influence lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. If this growth rate was applied continuously to a hypothetical resident population of 250 lynx (the midpoint of the range in the number of resident lynx this geographic may support based on expert opinion [Lynx SSA Team 2016, p. 41]), the population would decline to 100 lynx after 11 years, about 50 lynx after 20 years, and roughly 20 individuals after 30 years. Vulnerability to demographic, environmental, and genetic stochasticity would increase as lynx numbers decreased, resulting in an increased likelihood of functional extirpation of lynx from this unit. However, as noted above, the lynx population in the Purcell Mountains in the northwestern part of this unit was estimated to be increasing ($\lambda = 1.16$, 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) over the last four years of the period for which the Seeley lake population was estimated to be declining. In the absence of information on historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.4 Unit 4 - North-central Washington

Expert Projections of Future Lynx Status

Compared to the previous units, most expert graphs showed a lower probability of persistence for this unit over the short term, and then lower probability of persistence along with increasing uncertainty by 2100, reflecting a more pessimistic outcome for this unit compared to previous units (Figure 11). Experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), and mid-century persistence at 30% to 80% (median = 70%). All experts predicted end-of-century persistence probabilities less than 50%, with a median of 38%, by 2100 (Figure 11). However, one expert predicted an increase in persistence probability by mid-

century as habitats impacted by recent large-scale fires regenerate into optimal hare-lynx habitat.

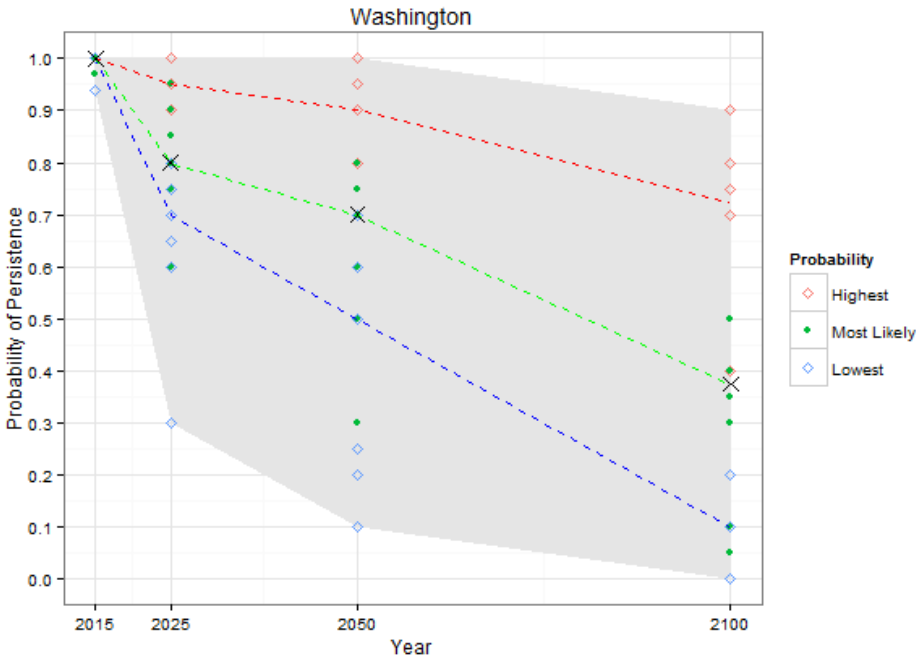


Figure 11. Lynx expert estimates of the probability that the North-central Washington Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

The probability of lynx persistence in this unit could decrease sharply over the next 10-20 years because of extensive recent fires in lynx habitats and the time needed for these areas to regenerate back to good hare/lynx habitat. After that, the probability could rebound (or decline more slowly) over the longer term as these large areas return to prime habitat providing high hare densities. The current small population is likely at greater risk of extirpation because of stochastic events, particularly if large fires in lynx habitat continue to occur in the near future as they have in the recent past. A small population also could be more susceptible to disease, though none has been documented among lynx in this unit. Experts discussed the extent to which small lynx populations could be reduced before they would become highly susceptible to stochastic demographic effects. It was suggested that 15-20 breeding individuals might be the minimum needed to avoid such susceptibility. Unimpeded connectivity between Canada and the Okanogan area of this unit could allow lynx to repopulate currently-unsuitable areas after the habitat recovers. Lynx in this unit are likely the southern portion of a larger population in

Canada, not really a separate, isolated small population. Factors that influenced expert persistence probabilities for this unit included fire, habitat loss, and the future loss of favorable snow conditions predicted by climate change models.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - As stated previously, it appears that, currently, adequate protective regulatory mechanisms are in place in this geographic unit. Looking to the future, relative to the regulatory risks to lynx, we do not anticipate the existing regulatory protections for lynx to diminish. We anticipate that either the CA will remain in place (and/or be extended), or the OWNF and CNF will revise or amend their respective LRMPS incorporating direction for lynx management similar to what has occurred with other 18 National Forests in Idaho, Montana, Utah, and Wyoming. These 18 National Forests amended their respective LRMPs with lynx management direction known as the Northern Rockies Lynx Amendment (NRLA) in 2007. The NRLA incorporated management recommendations from the LCAS, with modifications based on the advent of new information pertaining to the management of lynx. Currently, both the OWNF and CNF are in the process of amending or revising their LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended LRMP. Also, as discussed previously, the WADNR has developed and is implementing its 2006 Lynx Plan. The WADNR commits to implementing the 2006 Lynx Plan until lynx are delisted or until 2076, whichever is shorter (WADNR 2006, p. 6). Thus, it appears the regulatory future of lynx management, and thus, lynx habitat management, is largely secure on both federal and state managed lands within Washington State.

Comment [MJM75]: Need to specifically what we expect if lynx were not listed.

Climate Warming - The one risk factor identified by the LCAS over which the Forest Service, or the WADNR for that matter, has little ability to control or influence is climate change. Climate change was identified by the panel of lynx experts convened during development of the Canada Lynx Expert Elicitation Workshop Report to potentially represent the greatest threat to the long-term persistence of lynx (Lynx Workshop Report 2016, p. 56).

Potentially further exacerbating the recent losses of lynx habitat from fires is climate change. Climate change may affect fire return intervals and severity as well as the quality and depth of snow within lynx habitat. Westerling *et al.* (2006, pp. 942-943) compiled information on large wildfires in the western U.S. from 1970-2004 and found that large wildfire activity has increased significantly from the mid-1980s with large-wildfire frequency, longer wildfire duration, and longer wildfire seasons. The greatest increases occurred in high elevation forest types including lodgepole pine and spruce fir in the northern Rockies (i.e., lynx habitat). They also found that fire exclusion had little impact on natural fire regimes. Rather, climate appeared to be the primary driver of increasing wildfire risk. As stated previously, Koehler's (1990, p. 847) estimated adult lynx density of 2.3 lynx/100 km^2 was obtained in an area supporting high quality lynx habitat in the Meadows area of north central Washington (at least relative to other lynx habitat in Washington). Much of the lynx habitat in the Meadows was impacted by the recent large, stand replacing fires in the Cascades, resulting in further fragmentation of lynx habitat in

the northern Cascades. Thus, the lynx densities Koehler observed in his study area may not be currently supported, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines.

Additionally, relative to the persistence of Washington's lynx population, during the lynx expert elicitation workshop several of the lynx experts expressed concern that should more wildfires occur within the next 10 years and result in losses of lynx habitat similar to the impacts caused by the recent wildfires, such wildfires could result in the functional extirpation of lynx in Washington. The experts expressed heightened concern of functional extirpation of lynx in this geographic unit from wildfires due to its small size and current lynx population (Lynx Workshop Report 2016, p. 27). However, the experts felt the potential extirpation of lynx, should it occur from a large catastrophic wildfire(s) (or other mechanisms such as insect outbreaks), may be ameliorated to some extent due to Washington's juxtaposition and connectivity to Canadian lynx populations. The experts felt that lynx immigration from Canada may rapidly recolonize Washington as the habitat recovers from fires or other impacts (Lynx Workshop Report 2016, p. 43). Climate change, in addition to potentially affecting fire return intervals, fire severity (intensity, size), and insect outbreaks, is likely to affect the amount of precipitation falling as snow at elevations typically supporting lynx habitat in this geographic unit.

Lynx survive in areas with cold, snowy winters providing deep, fluffy snow (78 FR 59443) that gives lynx competitive advantages over other competitors and predators of lynx, as well as providing the conditions supporting the lynx's main prey, the snowshoe hare, which can comprise as much as 97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448).

Climate change may impact the quantity, quality, and temporality of snow in the Cascades. Mote (2003, pp. 272, 274), who evaluated temperature trends in the Pacific Northwest using data collected by weather stations from 1930 to 1995, determined that the temperature increased in the Pacific Northwest, and more precipitation fell in the spring and summer months, especially at elevations below 1,800 m (5,900 ft). Additionally, Mote (2003, pp. 2-3) determined that an increasing temperature and precipitation trend from 1950 to 2000 is correlated with a 40 percent decrease in the snow water equivalent in the Cascades. Mote *et al.* (2005, p.45) determined that the Cascades are very sensitive to temperature changes, with large increases in temperature potentially resulting in significant declines in snowpack. Corroborating Mote's speculation, Stoelinga *et al.* (2010, p. 2474) determined that the Cascade snowpack has declined by up to 40 percent in the latter half of the twentieth century, which resulted from increased temperatures. Furthermore, predicted continued increasing temperature changes of 2° C to 5° C over the next century are expected to cause further and accelerated losses in snowpack in the Cascades (Mote *et al.* 2005, p. 48). Continued declines of snowpack in the Cascades through 2025 are predicted to range from 9 percent (Stoelinga *et al.* 2010, p. 2486) to 29 percent (Elsner *et al.* 2010 *cited in* Stoelinga *et al.* 2010, p. 2486), which may also affect lynx densities supported in the Cascades. Finally, some of the best lynx habitat in this geographic unit occurs on plateaus that may be more vulnerable to impacts of climate change because of the absence of higher elevation areas to which habitats and lynx could migrate in response to

climate warming (Lynx Workshop Report 2016, p. 42). Thus, in addition to the recent losses of lynx habitat to large wildfires, coupled with increasing wildfire risk, the potential for the Cascades to support a viable lynx population may be further reduced due to decreasing quantity and quality of snow.

Similar to the potential effects of wildfires on the persistence of the lynx population in this geographic unit, the lynx experts identified climate change relating to loss of favorable snow conditions as a significant factor potentially affecting the long-term persistence of this population (Lynx Workshop Report 2016, pp. 43-44). Taking all factors into consideration (i.e., catastrophic wildfire, insect outbreaks, loss of snow), the experts felt the probability of this population persisting to the year 2050 most likely ranged between approximately 60 percent to 80 percent, declining by the year 2100 to approximately 30 percent to 50 percent (Lynx Workshop Report 2016, p. 43).

5.2.5 Unit 5 - Greater Yellowstone Area

Expert Projections of Future Lynx Status

The expert graphs for this unit were widely variable and had different outcomes and high uncertainty at all time frames. Experts predicted near-term (year 2025) persistence probabilities of 10% to 70% (median = 52%), and mid-century persistence at 15% to 60% (median = 35%). All experts predicted end-of-century persistence probabilities less than 50% for this unit, with a median of 15%, by 2100 (Figure 12). This was the only unit for which most experts believed the present probability of persistence is low (i.e., that it is uncertain whether this area currently supports a resident lynx population). Some experts increased probability of persistence into mid-century as the 1980s-era fires regenerate into hare/lynx habitat, and with the possibility of continued immigration of lynx from Colorado. Other experts project a 10% to 20% probability of persistence by 2100. One reason given for wide variability in responses is because of the uncertainty whether a population currently exists. There were wide confidence intervals around the probabilities for all time periods for this area.

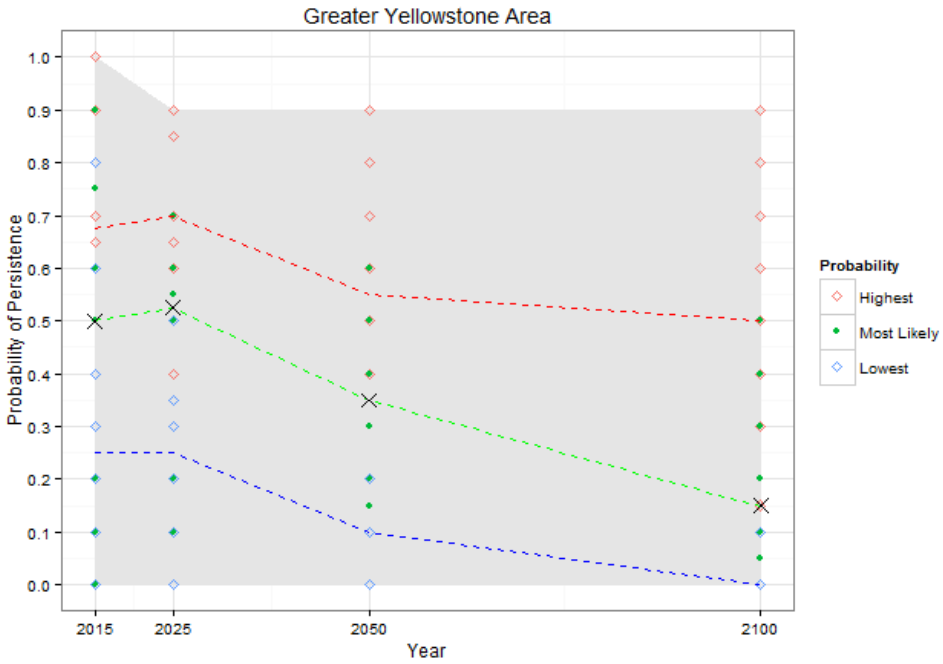


Figure 12. Lynx expert estimates of the probability that the Greater Yellowstone Area Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Current and future factors expressed by experts as influencing probability of persistence for this unit included small population size, forest disease and insect pests, and fire. Some experts doubt that the GYA unit currently supports a resident breeding population of lynx. Experts indicated that climate models predict that some parts of the GYA unit could provide refuge from climate change impacts because of their high elevations and potential to maintain winter snow levels into the future. Summer conditions in this unit, however, could be drier in the future, resulting in increased fire frequency, extent and intensity, and additional temporary habitat loss. However, regeneration of these areas and the extensive areas that have burned in the recent past may provide good habitat over the next several decades. Lynx immigrating to this unit from Colorado could occupy such improved habitats in the near future. Colorado lynx have made exploratory movements into the GYA in summer months, and analysis of available data could improve our understanding of Colorado lynx movement into and use of the GYA. It is possible that lynx from Colorado are maintaining or could maintain lynx in GYA.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - As noted above in section 5.2.3, federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Federal lands account for over 97 percent of this geographic unit; therefore, regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations. Also as described above, revisions or amendments to federal management plans require opportunities for public participation in accordance with NEPA, NFMA, National Parks and Recreation Act, and FLPMA (USFWS 2014 pp. 26-34; also see 3.1, above) and consultation with the Service in accordance with section 7 of the ESA. If the DPS were to be recovered and delisted in the future, the ESA requires a minimum of five years of monitoring to assess its ability to sustain itself without the ESA's protective measures. If, during that time, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (USFS 2007, Attachment 1, p. 2; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore potential lynx habitats in this geographic unit in the future.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support

conservation and restoration of lynx habitats in this unit and improve the likelihood that it will support resident lynx into the future. Because non-federal lands make up such a small proportion of this geographic unit, we believe it is unlikely that regulatory mechanisms on those lands will influence this unit's future ability to support resident lynx.

If the DPS ~~were to be delisted in the future~~was not listed, State-managed trapping could resume in this geographic unit. We expect that would occur only if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Comment [MJM76]: See previous related comment.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.5, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 46). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely further compromising this unit's ability to support resident lynx populations, which is already questionable.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, including the extensive fires in Yellowstone National Park in 1988, which burned over one-third of the park. Climate warming has also been linked to increased frequency

and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of landscapes in the GYA to support resident lynx may be further compromised, and resident lynx may be unable to persist until favorable vegetation conditions return. This is especially true where potential habitats are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will further reduce this geographic unit's ability to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx and habitats in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will further reduce habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.5, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current Ffederal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.5, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although the extent to which increased wildfire activity has impacted this unit's current ability to support resident lynx is uncertain, such impacts may become more likely in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand- initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support resident lynx until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.5, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – This geographic unit is not directly connected to lynx populations in Canada or elsewhere in the DPS range, although lynx released into Colorado have dispersed northward into and through this unit. There is little evidence of intermittent

immigration into this unit during past irruptions of lynx from Canada, as has been documented in other parts of the contiguous U.S. Nonetheless, as elsewhere in the DPS, immigration may influence the persistence of resident lynx in this unit. If continued climate warming or other factors further reduce the chances that dispersing lynx will reach this unit and contribute to its demographic and genetic health, either through habitat loss and fragmentation in potential dispersal corridors or declines in the amplitude of northern hare and lynx population cycles, the likelihood that the unit will support resident lynx in the future may also decline. However, as in Unit 3 above, because we lack information of historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.6 Unit 6 - Western Colorado

Expert Projections of Future Lynx Status

The majority of the experts suggested an initially high probability of persistence in Colorado, declining gradually with increasing uncertainty through the end of the century. Experts predicted near-term (year 2025) persistence probabilities of 60 percent to 100 percent (median = 90 percent), and mid-century persistence at 50 percent to 85 percent (median = 80 percent). Experts predicted end-of-century persistence probabilities of 20 percent to 70 percent for this unit, with a median of 50 percent, by 2100 (Figure 13).

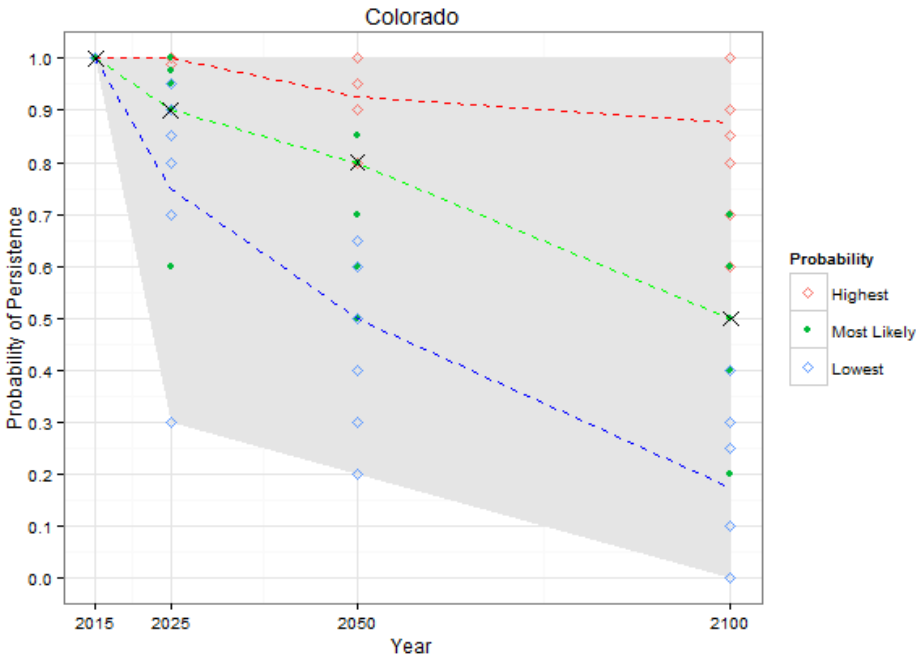


Figure 13. Expected probability of persistence for the Western Colorado Geographic Unit at present, 2015, and in 2025, 2050 and 2100.

Some experts indicated that beetle kill and fire could potentially create poor habitat conditions in large areas of this unit by mid-century, but that regeneration after these impacts could result in good lynx/hare habitats. Others expressed uncertainty about whether fire and insect impacts would be temporary or permanent, especially considering climate change and the potential for conversion from boreal/subalpine forests to other forest types. Although 8 of 10 experts graphed 50 percent to 70 percent probability of persistence at 2100, during subsequent discussions, several expressed greater uncertainty about whether resident lynx will persist in the unit at the end of the century. Higher-quality lynx habitat occurs primarily in two areas and is patchily-distributed. Lynx in this unit may occur as several smaller, relatively isolated subpopulations, which are likely more vulnerable to stochastic events. This unit's relative isolation may limit exchange with other lynx populations, increasing the likelihood of genetic drift and reducing the chance of demographic rescue or recolonization if lynx in the unit become extirpated. There was discussion about whether ski areas may affect daily movements of lynx, and hares may be declining in ski areas. Ski areas tend to expand and may, therefore, have larger impacts on lynx in future. There is some evidence of lynx using ski areas in summer months but avoiding them during the ski season. It is uncertain whether ski areas may affect genetic connectivity within the Western Colorado geographic unit. Two-thirds to three-quarters of the lynx in this unit are in the southern portion of the range in the San Juan Mountains. There is a large area (Weminuche

Wilderness) in Colorado that has not been well surveyed for lynx, so it is possible that lynx also could be using that area.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - Regulatory mechanisms for the conservation of lynx in the Southern Rockies consist of seven amended USFS management plans in south-central Wyoming, and Colorado. We concluded that the Southern Rockies Lynx Amendment substantively reduced the inadequate regulatory mechanisms by addressing the major adverse impacts of Forest Service land management on lynx (Service 2008, p 70-71). Lynx habitat on all other ownerships makes up the remaining 15 percent of lynx habitat in Colorado, of which, only five percent is in federal ownership. Other ownerships include state, county, municipal, etc., and private lands. The BLM resource management plans have not been amended to include conservation specifically for lynx and, with a few exceptions. Lynx habitat on BLM ownership mostly consists of narrow forest extensions connected to larger blocks of habitat on adjacent USFS lands. Generally these extensions are insufficient on their own to support a lynx home range. However, the Gunnison Field Office is the only BLM unit that contains sufficient habitat to map and identify LAUs.

The State of Colorado manages lynx as a state endangered species C.R.S. 33-2-105, prohibiting take of the species with exceptions for protection of human life (C.R.S. 33-6-205 and incidentally during depredation management (not caused by lynx) [C.R.S. 33-6-207].

Climate Change - ILBT (2013 p. 61) – “Climate change generally is expected to result in warmer winters, earlier spring snowmelt, and a reduction in the extent of snow cover in the southern Rockies. McKelvey *et al.* (2011 entire in ILBT 2013) used a variety of climate models to predict snow depth and the persistence of spring snow across the western United States. The models predicted an overall decline in persistent snow of 40 percent, but large areas of persistent snow would continue to be retained late in the 21st century, including the high elevations of Colorado.”

“All of the climate models under all representative concentration pathway (RCP) project that Colorado’s climate will warm substantially by 2050. Under RCP 4.5 (medium-low emissions scenario), Colorado’s annual temperatures are projected to warm by +2.5°F to +5°F by mid-century relative to 1971–2000 observed baseline. Under RCP 8.5 (high emissions scenario), Colorado’s annual temperatures are projected to warm by +3.5°F to +6.5°F by mid-century. Summers are projected to warm slightly more than winters under both RCPs. Looking beyond the 2050-centered analysis period, the warming trend is projected to continue into the late-21st century under all RCPs except RCP 2.6. By the period centered on 2070 (2055–2084), the projected warming in Colorado annual temperatures under RCP 4.5 is +2.5°F to +6.5°F relative to the 1971–2000 baseline. Under RCP 8.5, the projected warming is +5.5°F to +9.5°F relative to the 1971–2000 baseline.” [Lukas *et al.* 2014 page 61]

An analysis of projected 21st century temperature trends as a function of elevation in the Northern Hemisphere mid-latitudes from CMIP5 models shows more warming at higher

elevations during winter, particularly in the daily minimum temperature (Rangwala *et al.* 2013 [cited in Lukas *et al.* 2014 page 63]). “However, as discussed in Section 3, the global climate models do not represent the topography of Colorado very well, so it is difficult to discern whether the warming projected for the higher elevation regions (>10,000’) in the state is substantially different from that projected for lower elevations” (Lukas *et al.* 2014 page 63).

On average, the climate models indicate a seasonal shift in precipitation for Colorado, with increasing winter precipitation, and in some areas a decrease in late spring precipitation (Lukas *et al.* 2014, page 65).

Vegetation Management - In the past decade, vegetation management within lynx habitat has been predominantly salvage of dead and dying timber caused by a mountain pine beetle infestation in the northern part of the state (generally north of Interstate 70), and a spruce bark beetle infestation south of the interstate. Salvage operations may temporarily impact understory regeneration, if present, reducing the capacity of the stand to support higher snowshoe hare densities. Assuming the existing US Forest Service plans retain their current conservation framework, USFS lands should continue to provide sufficient habitat for lynx through the end of the century.

Vegetation management on non-federal ownerships within lynx habitat is unlikely to cause significant concern for lynx conservation in Colorado through the remainder of the century.

Wildland Fire Management - “It is generally acknowledged that in the Southern Rocky Mountains fire suppression has altered historic vegetative patterns. This effect has been most pronounced within vegetation communities where fire regimes are of low intensity or mixed severity. It is generally agreed that spruce-fir habitats have been little affected by fire suppression because the fire regimes within this type tend to be stand-replacing events occurring at long intervals (100+ years). Depending on the moisture regime, large stand-replacing fires within lynx habitat may produce young age class snowshoe hare habitat after approximately 10-30 years. Although this vegetative condition may provide some high quality snowshoe hare habitat, mature forests are also very important as winter foraging habitat.” (USFS 2008 page 36)

Habitat Fragmentation - Sources of current habitat fragmentation include high-speed high-volume highways, high mountain valley developments, vegetation management, ski/recreation area development, and wildland fire. Currently, only vegetation management on USFS lands is managed to limit lynx habitat fragmentation. Highways are likely to be expanded to accommodate increasing traffic volume as mountain valley communities continue to be developed and expended. While these linear features already exist on the landscape, widening of the cleared right-of-way, as well as behavioral avoidance of highway rights-of-way due to traffic reduces available habitat. Many ski areas in Colorado are located within lynx habitat and will likely be expanded in the future through permanent removal of vegetation to create conventional ski runs, reducing tree density and clearing understory vegetation to create glade conditions, reduces lynx habitat. The magnitude of fragmentation caused by these sources of

has not been quantified, but is unlikely to remove enough habitat to eliminate the possibility of lynx persistence in Colorado.

Chapter 6: Synthesis

This section synthesizes the needs, current condition, and likely future condition of the Canada lynx in the contiguous U.S. DPS with respect to the conservation biology principles of representation, redundancy, and resiliency. Its purpose is to provide an understanding of the range-wide status of this DPS that is as clear as possible given the unavoidable uncertainties involving demography and long-term threats.

Comment [MJM77]: See my comments on executive summary, which pulls many of the conclusions form this chapter. I did not repeat hose comments here.

Comment [MJM78]: Where do we explain whether we agree or disagree with the experts' opinions and why? The "Service evaluation" for each unit seems to be independent of he discussions about the preceding "Expert Projections" for each unit I was expecting this explanation to be in he Service evaluations or here.

Needs

Throughout the species' range, the lynx is a habitat and prey specialist requiring boreal forests with dense horizontal cover, long winters, and deep, fluffy snow, which gives it a competitive advantage for exploiting its primary prey, the snowshoe hare. Lynx in the contiguous U.S. have ecological requirements similar to those of lynx in Canada and Alaska, and throughout the species' range hare abundance is the primary driver of lynx population dynamics. However, the DPS is at the southernmost margin of the species' range, where boreal forests transition to temperate conifer and hardwood forests, and where snow conditions and hare abundance generally become less favorable with decreasing latitude. Because of this, habitat is less extensive and generally more fragmented within the DPS range than in the core of the species' range in Canada and Alaska. As a result, lynx in the contiguous U.S. are naturally less abundant and more patchily distributed than in the core of the range. Maintaining connectivity between lynx populations in Canada and the DPS is thought to be important; however, whether and if so to what extent the demographic and/or genetic health of DPS populations relies on periodic immigration from Canadian populations remains uncertain.

Current Conditions and Threats

Resiliency, the ability to withstand stochastic disturbance events, and redundancy, the ability to withstand catastrophic events, are currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. Available information indicates that five out of six geographic units in the DPS contain resident breeding lynx populations. Although we have no reliable population-size estimates for any of the geographic units, Northern Maine (Unit 1) is believed to currently support the largest resident population in the DPS. In Northeastern Minnesota (Unit 2), a resident population occupies the Arrowhead Region of the State. Northwestern Montana and northeastern Idaho (Unit 3) continue to support resident lynx, although a small subpopulation in the Garnet Mountains on the southern periphery of this unit may have been extirpated recently. In North-central Washington (Unit 4), recent extensive wildfires have temporarily reduced the amount of high-quality lynx habitat and may have caused a decline in lynx numbers there. Since the release of Canadian and Alaskan lynx in 1999-2006, resident lynx currently occupy western Colorado (Unit 6). The Greater Yellowstone Area (GYA, Unit 5) is thought to have historically supported a small

resident population; however, resident lynx have not been documented recently in this unit. The apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historic conditions suggest the historical and recent resiliency of lynx populations in the DPS. The large sizes and broad geographic distributions of the areas occupied by resident lynx populations likewise indicate adequate historical and current redundancy in the DPS to preclude its extirpation because of catastrophic events.

Representation, the ability of a species to adapt to changing environmental conditions over time, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Information provided by lynx experts and geneticists indicates high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Hybridization with bobcats has been documented but is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Thus, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions.

The primary threat identified at the time of listing, lack of regulations protecting lynx habitat on federal lands, has been largely addressed by formal and binding amendments or revisions to most federal land management plans within the DPS range. Although questions remain about the efficacy of this improved regulatory framework, federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands. Most federal lands, which constitute 64 percent of lynx habitat evaluated in this SSA, are found in the western U.S.

Other stressors affect lynx in one or more geographic units. For example, in northern Maine, where most high-quality lynx habitat occurs on private commercial timber lands and is the result of past timber harvest, changes in State forestry regulations (the Maine Forest Practices Act of 1989) that govern private forest management may currently be causing decreases in habitat quantity, quality, and distribution, and in lynx numbers (also see *Future Conditions and Threats*, below). The lack of binding lynx conservation commitments on private lands may exacerbate this risk to current lynx habitats in Maine. In North-central Washington, recent large-scale wildfires have resulted in the temporary loss of nearly 50 percent of lynx habitat, likely reducing this unit's current lynx population and potentially compromising its current ability to support a

resident population until habitats recover. Increased wildfire activity also has impacted lynx habitats in the other western geographic units (Northwestern Montana/Northeastern Idaho, the GYA, and Western Colorado), but the extent to which it has influenced the current condition of lynx populations in those units is uncertain.

Climate change is occurring at a global and, thus, a DPS-wide scale. Climate warming has reduced snow amount, duration, and quality (in terms of conditions favorable for lynx), it has been linked to increased frequency, size, and severity of wildfires and forest insect outbreaks, and it likely has already resulted in some changes in forest vegetative communities. Climate warming has also been linked to changes in the amplitude, periodicity, and synchronicity of northern hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in the DPS depend on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and an increased likelihood of extirpation among resident populations would be expected. However, whether, and if so to what extent, these climate-mediated factors have influenced current lynx numbers, other demographic parameters, and/or habitat quality and distribution is uncertain and has not been quantified across the range of the DPS or in individual geographic units. Despite uncertainty regarding its influence over current conditions for lynx, climate modeling and expert opinion concur that continued climate warming will adversely impact lynx in the DPS in the future (see below).

Future Conditions and Threats

Overall, ~~expert opinion and~~ our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). Forest management on private lands that lack lynx conservation commitments may also contribute to future declines, particularly in northern Maine. In each geographic unit, the probability that resident lynx populations will persist is expected to decline. The loss of resident lynx from one or more geographic unit would represent reduced future resiliency, redundancy, and representation within the lynx DPS.

The resiliency of lynx populations in individual geographic units is the primary determinant of the future viability of the lynx DPS. ~~Expert opinion and o~~Our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the

timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible to stochastic events.

The loss of any geographic units would also reduce the level of redundancy and could diminish representation within the DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation of one or more of the individual geographic units (e.g., fires in north-central Washington, as described above), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and likely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Furthermore, based on expert input, we conclude that there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS. How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Given the high percentage of federal land ownership in the West, regulatory commitments that these lands will continue to be managed in accordance with lynx conservation principles, and

Comment [MJM79]: Does this document explain how we arrive at this conclusion? If so, summarize it here. And do this for every conclusion.

the existence of potential high-elevation climate refugia to which lynx habitats and some lynx might move, the western geographic units (Units 3-6) may be more likely to support resident lynx longer under projected continued climate warming. Nonetheless, it is unlikely that any management actions can abate the long-term retreat of boreal forests and diminished snow conditions projected by climate models. Further, the size, frequency, and intensity of wildfires and forest insect outbreaks are expected to increase with continued climate warming, particularly in the western portion of the DPS, although we do not anticipate such events in-and-of-themselves are likely to cause the permanent loss of breeding lynx populations in any geographic unit.

Although projections of climate-mediated losses of boreal forests and favorable snow conditions suggest impacts to lynx and hare populations throughout the DPS, persistence of resident lynx in Maine and Minnesota may be relatively lower than the western geographic units given the smaller percent of federal lands and the absence of associated regulatory commitments to lynx conservation, and the lack of potential elevational refugia. Additionally, as noted above, changes to regulations governing timber harvest on private forest lands in Maine are unlikely to maintain the current historically-high amount and distribution of good lynx habitat or the current large population of resident lynx. These changes, which may affect over 90 percent of lynx habitats in northern Maine, are projected to result in substantial declines in habitat quality and distribution, and lynx numbers, over the next 10-30 years, primarily through restrictions on clearcutting and the proliferation of partial harvesting, which are detrimental to snowshoe hare and lynx needs. On private forest lands, energy development (wind energy, mining), rapid turnover in ownership and parcelization of forest land, and uncertain forest markets may also reduce the future quality and quantity of lynx habitat.

DPS viability

Although all five geographic units that currently support populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century (Lynx SSA Team 2016, pp. 36-49, 58). All other geographic units have a 50 percent or greater expert-estimated probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century, with a moderate to high likelihood that resident lynx will be lost from two to four units by then. Potential elevational refugia may increase the likelihood of persistence in western units, although uncertainty remains about the timing of warming-driven upslope movements of habitats and snow conditions and the extent to which hare and lynx populations may follow them. Regardless, future lynx habitats throughout the DPS range are likely to be smaller and more fragmented, and geographic units that are already relatively isolated from other lynx populations are likely to become even more isolated in the future. Despite the lack of elevational refugia, lynx may also persist at the end of the century in Maine and Minnesota, depending on the timing and severity of climate change effects and, in Maine, on trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the

Comment [MJM80]: We never say whether we agree or disagree with hese specific experts' opinions and explain why. We make a meaningless statements in the end about probability of persistence, and that doesn't tell he reader whether we agree or disagree with hese specific opinions of the experts.

best available science in concert with input from lynx experts suggests that the probability of the persistence of resident breeding populations will decline in all geographic units beginning as early as 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the ~~potential~~ functional extirpation of resident lynx populations from one or more geographic units would demonstrate a loss of resiliency, reduced redundancy, and, possibly, reduced representation within the DPS. The~~se~~ probability of losses in resiliency, redundancy, and representation ~~will~~ puts the Canada lynx DPS at increasing risk of extirpation through the end of this century.

Comment [MJM81]: It actually starts now. All species have decreasing probability of persistence over time. That probability begins to decline immediately and never stays the same or increases.

Comment [MJM82]: It's not the potential but rather the actual extirpa ion that would demonstrate a loss of the 3Rs.

Comment [MJM83]: None of he overall conclusions helps decisionmakers understand how big the risk is. Recommend presenting our conclusions about the probabili ies of persistence.

From:	Miller, Martin
To:	Krishna Gifford; Anne Hecht
Subject:	Fwd: Lynx SSA comments
Date:	Tuesday, November 01, 2016 12:28:44 PM
Attachments:	2016 10 14 DRAFT Lynx SSA Report CLEAN_MJMcomments.docx

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In case your interested in my final comments.

---------- Forwarded message ----------
From: **Miller, Martin** <martin_miller@fws.gov>
Date: Mon, Oct 31, 2016 at 12:21 PM
Subject: Lynx SSA comments
To: Mark McCollough <Mark_McCollough@fws.gov>
Cc: Mary Parkin <mary_parkin@fws.gov>

Mark - Here are my comments on the lynx SSA. I focused on the Future Conditions and Synthesis chapters. I have three major comments:

1. Establishing the proper context for the future: This is a future with lynx not being listed. The document presents a delisting scenario in its evaluation of the Federal management future of the MT/ID Unit. I explain in my comments that, while the conclusions about what the future will look like may be OK, the way we get there needs to be revised. And this context needs to be established for evaluation across all units, actors (Federal agencies, states, landowners, etc.), and consequences (not just regulatory mechanisms).

2. Explaining how the experts' opinions inform our conclusions: The document does not explain what we think about the experts' opinions (agree or disagree and why). I was expecting this explanation for each unit in Chapter 5 in the "Service Evaluation" section, which follows the "Expert Projections,' but these two discussion appear to be independent. We continue to refer to the experts' opinions about persistence to the very end without ever saying whether we agree with them (and explaining why).

3. Drawing meaningful conclusions: The ultimate conclusions we make (the DPS has a decreasing probability of persistence into the future) is meaningless as it can be said of every species on earth. I recommend we present "our" conclusions on persistence. If we thought it was valuable to know what the experts think about persistence, we need to at least present our conclusions on persistence. I understand we are advised not to present our conclusions in a manner that too closely resembles a conclusion about listing being warranted or not. But we're too far down the "probability of persistence" road to avoid presenting our conclusions on this. And we need to do it in a way that describes the magnitude of the risk, not statements that are generalized to the point of being meaningless.

Many of the comments I made on the Executive Summary I did not bother repeating in the Chapters.

Let me know if you have any questions.
Marty

--
Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and

Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

--
Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

From:	Zelenak, Jim
To:	Jodi Bush
Subject:	Fwd: Lynx CH declaration
Date:	Tuesday, November 01, 2016 1:53:28 PM
Attachments:	LYNX_CH_-_59e_Reply_Dec_(DOJ and SOL edits) (1).docx LYNX_CH_-_59e_Reply_Dec_(DOJ and SOL edits) plus jz eds.docx

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Attached is the version that Kate sent me at about 11:30, with much strike-through from Lesley at DOJ.

In the second attachment, I've added my comments/edits/recommendations and tried to respond to the questions/comments that were already there. I also added the last numbered item in an attempt to include the direction Mike asked me to try to incorporate - not sure if that works.

Seth was not on the call earlier, though he had provided comments on an earlier draft of the declaration. We should forward the next version to him once you've reviewed/edited this one.

Let me know if you have questions or needed anything else.

Need to get this to Marj, Seth, Kate, Dana, and Lesley by COB today so Lesley can submit final to court by about 1 PM Eastern Time tomorrow.....

---------- Forwarded message ----------
From: **Williams-shuck, Kathryn** <kate.williams-shuck@sol.doi.gov>
Date: Tue, Nov 1, 2016 at 11:14 AM
Subject: Lynx CH declaration
To: "Zelenak, Jim" <jim_zelenak@fws.gov>

Kate Williams-Shuck
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--
Jim Zelenak, Biologist

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From:	Bush, Jodi
To:	Marjorie Nelson
Cc:	Zelenak, Jim; Willey, Seth; Kathryn Williams-shuck; Thabault, Michael
Subject:	Re: Lynx CH declaration
Date:	Tuesday, November 01, 2016 2:06:28 PM
Attachments:	LYNX_CH_-_59e_Reply_Dec_(DOJ and SOL edits) plus MTESO eds.docx

Here are our comments/edits on Mike's declaration. JB

Jodi L. Bush
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---------- Forwarded message ----------
From: **Williams-shuck, Kathryn** <kate.williams-shuck@sol.doi.gov>
Date: Tue, Nov 1, 2016 at 11:14 AM
Subject: Lynx CH declaration
To: "Zelenak, Jim" <jim_zelenak@fws.gov>

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--
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Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014, Federal Defendants hereby submit the following status report on the United States Fish and Wildlife Service's ("Service") recovery planning for the Canada lynx under 16 U.S.C. § 1533(f) for

the period of July 1, 2016 to January 1, 2017. *See* ECF No. 30.

1. In March, 2015, the Service determined that a Species Status Assessment ("SSA") was necessary to guide recovery planning direction for the lynx DPS. From July, 2016 through December, 2016, the Service continued weekly calls with the SSA Framework Implementation Team (which oversees development and completion of the SSA report); biweekly calls with the SSA Core Team (which drafts the SSA report and associated documents); and monthly calls with both Service field offices and State agency partners.
2. In August, 2016, the Service awarded a contract to Atkins North America to coordinate and compile the administrative record for peer review of the Draft SSA Report.
3. In October, 2016, the Service completed the Draft SSA Report and circulated it for internal agency review.
4. In November, 2016, the Service conducted a webinar to update State and Federal agency partners on the status of the SSA and provide time lines for the statutorily-required 5-year status review and subsequent recovery planning efforts.
5. In December, 2016, the Service provided the revised Draft SSA Report to the peer review contractor and to State, Federal, and Tribal partners for their

reviews and comments.

DATED: {date}.

Respectfully submitted,

JOHN C. CRUDEN
Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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FOR THE DISTRICT OF MONTANA
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Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
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DATED: {date}.

Respectfully submitted,

JOHN C. CRUDEN
Assistant Attorney General
SETH M. BARSKY, Chief
KRISTEN L. GUSTAFSON,
Assistant Chief

/s/ *Travis Annatoyn*
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Attorneys for Federal Defendants

From:	Zelenak, Jim
To:	Jodi Bush
Subject:	Draft Court Update - Lynx Recovery Plan
Date:	Tuesday, May 30, 2017 2:15:27 PM
Attachments:	DRAFT WILDLIFE-#293033-v1-_Lynx_RP__July_2017_status_report TRACK.doc DRAFT WILDLIFE-#293033-v1-_Lynx_RP__July_2017_status_report CLEAN.doc

---

This needs to go through Dana J. then DOJ and then gets submitted by latter to the court by July 1; wanted to get an early jump on it.

This is my first stab at the Jan.- June 2017 reporting period. Some questions about how to present Decision Team meetings (if at all). Let me know what you think.

Used the last report I had from DOJ as a template. TRACK and CLEAN versions attached.

Let me know if we need to discuss and what changes are necessary before we send this to Dana.

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Jodi Bush
To:	Justin Shoemaker
Cc:	marjorie_nelson@fws.gov
Subject:	Fwd: Draft Court Update - Lynx Recovery Plan
Date:	Thursday, June 01, 2017 1:48:08 PM
Attachments:	Untitled attachment 17224.htm DRAFT WILDLIFE-#293033-v1-_Lynx_RP__July_2017_status_report TRACK.doc DRAFT WILDLIFE-#293033-v1-_Lynx_RP__July_2017_status_report CLEAN.doc Untitled attachment 17227.htm

---

This is due beginning of July but I'm out of office til end of next week. Can you take a look?
JB

Sent from my iPhone

Begin forwarded message:

> **From:** "Zelenak, Jim" <jim_zelenak@fws.gov>
> **Date:** May 30, 2017 at 2:15:24 PM MDT
> **To:** Jodi Bush <jodi_bush@fws.gov>
> **Subject: Draft Court Update - Lynx Recovery Plan**
>
> This needs to go through Dana J. then DOJ and then gets submitted by latter to the court by July 1; wanted to get an early jump on it.
>
> This is my first stab at the Jan.- June 2017 reporting period. Some questions about how to present Decision Team meetings (if at all). Let me know what you think.
>
> Used the last report I had from DOJ as a template. TRACK and CLEAN versions attached.
>
> Let me know if we need to discuss and what changes are necessary before we send this to Dana.
>
> Thanks.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

From:	Shoemaker, Justin
To:	Jodi Bush
Cc:	Marjorie Nelson
Subject:	Re: Draft Court Update - Lynx Recovery Plan
Date:	Thursday, June 01, 2017 2:05:31 PM

I can take a look. Should I coordinate w/ Jim?

Justin Shoemaker
Classification Biologist
U.S. Fish and Wildlife Service, Region 6
Phone: 309-757-5800 x214
Email: justin_shoemaker@fws.gov

On Thu, Jun 1, 2017 at 2:48 PM, Jodi Bush <jodi_bush@fws.gov> wrote:

> This is due beginning of July but I'm out of office til end of next week. Can you take a look?
> JB
>
> Sent from my iPhone
>
> Begin forwarded message:
>
> **From:** "Zelenak, Jim" <jim_zelenak@fws.gov>
> **Date:** May 30, 2017 at 2:15:24 PM MDT
> **To:** Jodi Bush <jodi_bush@fws.gov>
> **Subject: Draft Court Update - Lynx Recovery Plan**
>
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>
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>
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>
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>
> Thanks.
>
> --
> Jim Zelenak, Biologist
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> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Justin Shoemaker
Subject:	Fwd: Draft Court Update - Lynx Recovery Plan
Date:	Friday, June 02, 2017 8:37:46 AM
Attachments:	DRAFT WILDLIFE-#293033-v1-_Lynx_RP__July_2017_status_report TRACK.doc DRAFT WILDLIFE-#293033-v1-_Lynx_RP__July_2017_status_report CLEAN.doc

Hey Justin,

Jodi will be out of the office most of next several working days and won't have time to review this semi-annual court update on the recovery plan lawsuit, so I'm sending it to you for your review. I discussed the issue of whether or not to include the Decision/Recommendation Team meeting and follow-up webinar (items 3 and 5 in attached), and her take was that those items should not be included in this update.

I've left them in the attached draft for now in case you, based on your experience with these and with working with Dana, feel differently (strongly).

Also, the technical editor Jodi had lined up to review the draft FINAL SSA Report has left the Service for another position and won't be able to do it. How do you feel about doing a close technical review of it when I have finished responding to peer and partner review comments and completed other edits? I hope to have that done in the next couple weeks, with the plan to send it to you, Jodi and the Core team for review, while I work on lit cited (along with Mark), and trying to get the final done by end of June as per Jodi.

Let me know if you'd like to discuss any of this.

Thanks,

Jim

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Tue, May 30, 2017 at 2:15 PM
Subject: Draft Court Update - Lynx Recovery Plan
To: Jodi Bush <jodi_bush@fws.gov>

This needs to go through Dana J. then DOJ and then gets submitted by latter to the court by July 1; wanted to get an early jump on it.

This is my first stab at the Jan.- June 2017 reporting period. Some questions about how to present Decision Team meetings (if at all). Let me know what you think.

Used the last report I had from DOJ as a template. TRACK and CLEAN versions attached.

Let me know if we need to discuss and what changes are necessary before we send this to Dana.

Thanks.

--
Jim Zelenak, Biologist
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--
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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Williams-shuck, Kathryn
To: Zelenak, Jim
Cc: Dana Jacobsen
Subject: Re: Attorney-Client Privilege - Lynx 5-year Reveiw Call
Date: Thursday, July 06, 2017 1:43:49 PM

Any of those should work for me.
Thanks,
Kate

Kate Williams-Shuck
Attorney-Advisor
U.S. Department of the Interior
Rocky Mountain Regional Solicitor's Office
755 Parfet Street, Suite 151
Lakewood, CO 80215
Main: 303.445.0600
Direct: 303.445.0597 *** new phone numbers ***
Cell: 303.842.5877
kate.williams-shuck@sol.doi.gov

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On Thu, Jul 6, 2017 at 1:22 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Dana and Kate,
>
> Justin has asked me to set up a call with you two along with he and I, Jodi, and Marj for early next week if possible.
>
> Could you let me know if any of the dates/times below work for you and, if so, which works best?
>
> 1. Mon., July 10, 9-10 AM MST
> 2. Mon., July 10, 11 AM-12 PM MST
> 3. Tues., July 11, 11 AM-12 PM MST
> 4. Tues., July 11, 2-3 PM MST
>
> Thanks,
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220

jim_zelenak@fws.gov

From: Zelenak, Jim
To: Jacobsen, Dana
Cc: Kathryn Williams-shuck
Subject: Re: Attorney-Client Privilege - Lynx 5-year Reveiw Call
Date: Thursday, July 06, 2017 2:49:50 PM

Thanks Dana, thanks Kate.

On Thu, Jul 6, 2017 at 2:22 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

> Hey there,
>
> The Monday time slots work for me. The Tuesday slots do not work!
>
> Thanks.
>
> DAna
>
> On Thu, Jul 6, 2017 at 1:22 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Dana and Kate,
> >
> > Justin has asked me to set up a call with you two along with he and I, Jodi, and Marj for early next week if possible.
> >
> > Could you let me know if any of the dates/times below work for you and, if so, which works best?
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> > 3. Tues., July 11, 11 AM-12 PM MST
> > 4. Tues., July 11, 2-3 PM MST
> >
> > Thanks,
> >
> > Jim
> >
> > --
> > Jim Zelenak, Biologist
> > U.S. Fish and Wildlife Service
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225 ext. 220
> > jim_zelenak@fws.gov
>
> --
> Dana Jacobsen
> Assistant Regional Solicitor
> Rocky Mountain Regional Office
> Office of the Solicitor
> 755 Parfet, Suite 151

> Lakewood, CO 80215
> (303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Jacobsen, Dana
To:	Zelenak, Jim
Subject:	Fwd: Lynx Recovery Planning; Draft Status Report
Date:	Monday, July 24, 2017 10:04:23 AM
Attachments:	WILDLIFE-#298644-v1-CANADA_LYNX_RECOVERY_PLAN_-_DN_52_-_STATUS_REPORT_Of....pdf

Here you go!!

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Thu, Jul 20, 2017 at 1:24 PM
Subject: Re: Lynx Recovery Planning; Draft Status Report
To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>
Cc: Jodi Bush <jodi_bush@fws.gov>

Hi Dana,

Could you send us a copy of the final status report that Travis filed for our records here when you have a chance?

Thanks!

--

Dana Jacobsen

Assistant Regional Solicitor

Rocky Mountain Regional Office

Office of the Solicitor

755 Parfet, Suite 151

Lakewood, CO 80215

(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

--
Dana Jacobsen

Assistant Regional Solicitor
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Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

JEFFREY H. WOOD
Acting Assistant Attorney General
SETH M. BARSKY, Chief
MEREDITH L. FLAX, Assistant Chief
TRAVIS ANNATOYN, Trial Attorney
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
(202) 514-5243 (tel)
(202) 305-0275 (fax)
travis.annatoyn@usdoj.gov

Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al., Plaintiffs, v. DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al., Defendants.	No. 13-cv-57-DWM DEFENDANTS' STATUS REPORT

Pursuant to the Court's order of June 25, 2014, Federal Defendants hereby submit the following status report on the United States Fish and Wildlife Service's ("Service") recovery planning for the Canada lynx under 16 U.S.C. § 1533(f) for

the period from January 1, 2017 to July 1, 2017. *See* ECF No. 30.

1. In March, 2015, the Service determined that a Species Status Assessment ("SSA") was necessary to guide recovery planning direction for the lynx Distinct Population Segment ("DPS"). From January, 2017 through June, 2017, the Service continued regular calls with the SSA Framework Implementation Team (which oversees development and completion of the SSA report) and with the SSA Core Team (which drafts the SSA report and associated documents). The Service has organized monthly calls or updates via electronic mail with Service field offices and with State and other Federal wildlife agency personnel.
2. In late February, 2017, the Service received comments on the Draft SSA Report from the wildlife agencies of 11 States within the DPS range. The Association of Fish and Wildlife Agencies consolidated and provided these comments to the Service, which also received comments from the Bureau of Land Management, the U.S. Forest Service, and the National Park Service.
3. In early March, 2017, the SSA Team convened a meeting with Service Leadership (*i.e.*, Assistant Regional Directors from Service regions 1, 3, 5, and 6; and the Regional Director from Region 6) in Denver, at which the SSA Core Team summarized the findings of the Draft SSA Report and the peer and State and Federal agency reviews to-date.

4. By mid-March, 2017, the Service received reviews of the Draft SSA Report from all five peer reviewers selected by the Service's peer review contractor, Atkins North America.
5. In mid-May, 2017, the SSA Team reconvened with Service leadership via webinar to review the findings of the Draft SSA Report and to consider recent peer and State and Federal reviews.
6. In February, 2017 through June, 2017, the SSA Core Team responded to peer and State and Federal review comments and revised the Draft SSA Report, with the intent to complete the Final SSA Report in summer, 2017.

DATED: July 1, 2017

Respectfully submitted,

JEFFREY H. WOOD
Acting Assistant Attorney General
SETH M. BARSKY, Chief
MEREDITH L. FLAX,
Assistant Chief
/s/ *Travis Annatoyn*
TRAVIS ANNATOYN, Trial Attorney
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
(202) 514-5243 (tel)
(202) 305-0275 (fax)
travis.annatoyn@usdoj.gov

Attorneys for Federal Defendants

From: Zelenak, Jim
To: Jacobsen, Dana
Subject: Re: Lynx Recovery Planning; Draft Status Report
Date: Monday, July 24, 2017 10:45:55 AM

Thanks.

On Mon, Jul 24, 2017 at 10:04 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

> Here you go!!
>
> ---------- Forwarded message ----------
> From: **Zelenak, Jim** <jim_zelenak@fws.gov>
> Date: Thu, Jul 20, 2017 at 1:24 PM
> Subject: Re: Lynx Recovery Planning; Draft Status Report
> To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>
> Cc: Jodi Bush <jodi_bush@fws.gov>
>
> Hi Dana,
>
> Could you send us a copy of the final status report that Travis filed for our records here when you have a chance?
>
> Thanks!
>
> --
>
> Dana Jacobsen
>
> Assistant Regional Solicitor
>
> Rocky Mountain Regional Office
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> Office of the Solicitor
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> 755 Parfet, Suite 151
>
> Lakewood, CO 80215
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> (303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Miller, Martin
To:	Anna Harris
Cc:	Peter Lamothe; Dave Rothstein
Subject:	Follow up from Lynx SSA - Attorney/Client Privalege - Do Not Release
Date:	Tuesday, August 08, 2017 11:00:25 AM

Hi Anna - OK, we'll wait to hear what Jodi says. We'll especially want to check to see if they dealt with the issues that MDIFW weighed in on. We need to make sure we have a good basis for disagreeing with MDIFW in our projections for how they would manage lynx and lynx habitat (incidental trapping and otherwise) in the absence of ESA protection. We'll also want to check to see if they've fixed the problems relating to conclusions not being adequately supported. Our job is to arrive at rational conclusions and persuasively explain why our conclusions are the most rational - Dave's comments zero in on where we should do this better. Marty

On Tue, Aug 8, 2017 at 8:47 AM, Anna Harris <anna_harris@fws.gov> wrote:

> Hi Marty,
>
> Wanted to follow up on the discussion from yesterday. I connected with Jodi Bush yesterday and we have a path forward:
> 1) I'll send Jodi and the R6 SOL Dave's comments.
> 2) Mark and I will wrap up our review/comments and send to Jodi Wednesday afternoon.
>
> It sounds like significant changes have already been made to the futures chapter so our office is not planning to address Dave's comments in that section. We will wait for Jodi's response on how to address comments once she and Jim have had a chance to review.
>
> Let me know if you have questions.
>
> Thanks,
> Anna
>
> Sent from my iPhone

--
Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

From:	Bush, Jodi
To:	Marjorie Nelson; Zelenak, Jim
Cc:	Justin Shoemaker
Subject:	Re: Lynx General
Date:	Monday, October 23, 2017 2:09:21 PM

Marj. when we talked last (on friday), I thought I remember you saying that Mike was going to ask SOLs NOT to review, again, the SSA. Did anything happen from that? JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Oct 23, 2017 at 12:44 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> My understanding is that R6 RSOL is reviewing the Final SSA Report and that we (I) will need to address comments/ concerns/ edits if they have any, and that could require changes/additions to the report. Is that correct?
>
> If so, any changes would have to be made before the 5-year review could be announced and made public, right?
>
> I ask because I'm in the office this week until 2:30 Mountain Time on Wednesday, then on leave and back in the office next Wed., Nov. 1.
>
> Please let me know what, if anything, I can do over next few days to be most helpful.
>
> Also, we have our monthly State/Federal Lynx coordination call this Wednesday at 1PM Mountain Time - any thoughts on whether we should hold that and, if so, what we can share?
>
> Thanks.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: lynx announcement
Date: Thursday, October 26, 2017 6:50:52 AM

Thanks Jim for all the hard work you have put into completing the SSA and 5-year review. Let us know when it is time for "next steps." Mark

On Wed, Oct 25, 2017 at 4:14 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> No - Think we have to leave it as is for now - maybe next version.
>
> On Wed, Oct 25, 2017 at 1:35 PM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Yes...I was on the last 5 min. of the call and heard Jim's questions about our HCP.
> >
> > Thanks for the heads up on the approximate announcement date. I know there is a lot of interest here.
> >
> > Not that I have much time, but are you still accepting page numbers for citations?
> >
> > Mark
> >
> > On Wed, Oct 25, 2017 at 3:31 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Jodi did not give a specific date but said in the next 1-2 weeks. She's aiming for next Fri., Nov. 3, but there is some question about R6 RSOL review/concern and need to clear with the courts, which, like with R5 RSOL, is coming up pretty late in the game.
> > >
> > > I've been only peripherally involved in review of the 5-year and had some input to (and some concern about) the draft news release and communications plan.
> > >
> > > Not sure if you were on when Jodi indicated that the 5-year received concurrence from all affected regions and is now in the R6 RO awaiting RD signature.
> > >
> > > I assume you heard Jim Connolly's questions and concern about whether there will be an opportunity for Maine/MDIFW to discuss the implications of the 5-year recommendation with the Service (R5) before the report and 5-year are made public. Jodi said she would pass that along to Paul P. and have him talk to Jim C.
> > >
> > > Hope all is well there. I'll be catching my breath for a few days before the FOIA requests begin to roll in....
> > >
> > > On Wed, Oct 25, 2017 at 1:20 PM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
> > >
> > > > Jim: I am on another conf call, but jumped on the lynx call late and briefly. Did we announce a date for release of 5-year review and SSA?
> > > >
> > > > thanks, Mark
> > > >
> > > > --
> > > > **PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED**

Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
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--
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Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
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Cell Phone: 207 944-5709
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Montana Ecological Services Office
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Helena, MT 59601

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jim_zelenak@fws.gov

--

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Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Bush, Jodi
To: Shoemaker, Justin
Subject: Re: Lynx 5YR w/ SOL edits added
Date: Monday, October 30, 2017 12:18:02 PM

Looks good. I like the characterization of what we identified as the threat (potential) in the original listing as well as that of the 5 year review.

One thing we might want to change. Not all of the federal mgmt plans have been revised. so on page 5 we could say: Nearly all Federal Land Management Plans....

thanks for your work Justin. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Oct 30, 2017 at 12:06 PM, Shoemaker, Justin <justin_shoemaker@fws.gov> wrote:

> Jodi and Marj,
>
> Here's a revised draft 5YR that includes the additions we discussed on Friday. Let me know what you think.
>
> Justin Shoemaker
> Classification and Recovery Biologist
> U.S. Fish and Wildlife Service, Region 6
> Phone: 309-757-5800 x214
> Email: justin_shoemaker@fws.gov

From:	Bush, Jodi
To:	Jim Zelenak
Subject:	Fwd: Canada lynx 4(f)(1) determination
Date:	Wednesday, November 15, 2017 12:59:43 PM
Attachments:	Canada Lynx 4(f)(1) determination_11152017.docx

take a look. I havent reviewed yet.

You did fine responding directly to Matt. but please dont make promises :) JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

---------- Forwarded message ----------
From: **Shoemaker, Justin** <justin_shoemaker@fws.gov>
Date: Wed, Nov 15, 2017 at 9:21 AM
Subject: Canada lynx 4(f)(1) determination
To: Marjorie Nelson <marjorie_nelson@fws.gov>, Jodi Bush <jodi_bush@fws.gov>

After talking w/ Maricela at HQ, it appears we need to do a 4(f)(1) determination (see attached draft) to be square w/ our Recovery Planning guidance and the Act. The Service has done very few of these over the years, and to our knowledge, never in a situation like we have for lynx. The attached determination memo has in the past been signed at the Director level, and I have it drafted as such.

I know we're waiting to hear from Dana and DOJ on the necessity for some kind of memo to the court regarding the 2014 Order, but if we have to do this determination memo anyway, maybe this can serve that purpose as well?

Please take a look. And let me know if I should share w/ RSOL now.

And if a call to discuss is desired, I can try and set that up, but availability for everyone is tight this week.

Justin Shoemaker
Classification and Recovery Biologist
U.S. Fish and Wildlife Service, Region 6
Phone: 309-757-5800 x214
Email: justin_shoemaker@fws.gov

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO:
FWS/R6/ES

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Boulevard
Lakewood, Colorado 80228-1807

Memorandum

To: Director (AES)

From: Regional Director, Region 6

Subject: 4(f)(1) Determination Regarding Recovery Planning for the Canada Lynx (*Lynx Canadensis*)

Region 6 is currently the lead Region for the contiguous United States (U.S.) distinct population segment (DPS) of the Canada lynx under the Endangered Species Act (Act). By this memorandum, I am requesting that the U.S. Fish and Wildlife Service (Service) make a determination under 16 USC § 1533(f)(1) that development of a formal recovery plan at this time would not promote the conservation of the lynx DPS. Your approval signature is requested at the end of this memorandum.

The Service listed the lynx DPS as a threatened species under the Act in 2000 (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (i.e., the DPS is recovered or no longer warrants ESA protections; U.S. District Court MT 2014b, p. 2).

The Service listed the lynx DPS as threatened in 2000 because of the *potential for impacts* to lynx habitat conditions and the availability of prey populations within the lynx DPS and existing regulatory mechanisms on Federal lands, *at that time*, did not provide sufficient guidance for the conservation of lynx habitats and populations or prey habitat in light of *potential threats* (65 FR 16052-16086). Federal lands management plans, at that time, allowed for forest management practices that could potentially reduce lynx habitat on a population level scale, thereby creating a future risk to the species existence in the DPS. Nearly all Federal land management plans throughout the DPS have since been revised to include science- and research-based measures and management practices consistent with lynx conservation, thereby greatly reducing the risk of future population scale habitat deterioration on Federal lands (Service 2017, p. 5).

We recently completed a 5-year status review that recommends delisting the lynx DPS (Canada Lynx 5-Year Review 2017, entire). Our status review was informed by a comprehensive Species

Status Assessment (SSA) Report that summarizes the best available scientific information on the current status and likely future viability of the DPS (SSA Report, entire). The peer and partner reviewed SSA Report provides the scientific basis for the 5-year review.

Under the ESA, a threatened species is any species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The foreseeable future refers to the extent to which the Secretary can reasonably rely on predictions about the future in making determinations about the future conservation status of the species (U.S. Department of Interior, Solicitor's Memorandum, M-37021, and January 16, 2009). The key statutory difference between a threatened species and an endangered species is the timing of when a species may be in danger of extinction, either now (endangered species) or in the foreseeable future (threatened species). In the SSA, we considered the future condition of the lynx DPS out to 2025, 2050, and 2100 (SSA Report, chapter 5). It became apparent through discussions with lynx experts, in peer and partner reviews of the draft SSA Report, and among Service biologists and management that any future projections of lynx status beyond mid-century were complicated by a very high degree of uncertainty concerning the timing and extent of various stressors that may affect lynx and hare habitat and snow regimes, especially those related to projected future climate change (SSA Report, chapter 5.1). Therefore, in our 5-year review evaluation, we identified mid-century (2050) as the foreseeable future because this time horizon gives us a higher degree of certainty in reasonably projecting the future condition of the lynx DPS (Canada Lynx 5-Year Review 2017, p. 6).

As discussed in the SSA Report, resident lynx populations in all geographic units that currently support them are expected to be smaller and more fragmented and isolated in the future, and each geographic unit and the DPS as a whole will be less resilient in the future (SSA Report, pp. 173, 236). However, all five geographic units that currently support resident lynx populations (all units except the Greater Yellowstone Area) are expected to continue to do so through mid-century (2050) (SSA Report, p. 236). Our analyses, as informed by expert input, suggest that resiliency will likely be sufficient to foster persistence (i.e., preclude extirpation) of resident lynx through mid-century in all or most of the five geographic units that currently support them (SSA Report, p. 236). At mid-century, we expect lynx to retain a wide geographical distribution of populations, maintaining redundancy within the DPS (SSA Report, p. 236). Should lynx populations in each geographic unit become smaller and more patchily distributed, reduced genetic health and/or adaptive capacity would be expected; however, we have no information to suggest reduced representation would be a DPS-level concern at mid-century (SSA Report, chapter 6). Therefore, we conclude that the risk of extinction (extirpation of the DPS) by 2050 is sufficiently low that the lynx DPS is not likely to become endangered throughout all of its range within the foreseeable future and therefore does not meet the definition of a threatened species (Canada Lynx 5-Year Review 2017, p. 6).

Section 4(f)(l) of the Act requires the Service to develop and implement recovery plans for species listed as endangered or threatened, "unless [the Service] finds such a plan will not promote the conservation of the species. " The definition of conservation, in Section 3(3) of the

Act means" ... all methods and procedures which are necessary to bring any endangered or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary".

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APPROVED BY _____ DATE _____
Director, U.S. Fish & Wildlife Service

From: Zelenak, Jim
To: Bush, Jodi
Cc: Justin Shoemaker
Subject: Re: Canada lynx 4(f)(1) determination
Date: Wednesday, November 15, 2017 1:44:49 PM
Attachments: 2017 11 15 DRAFT Canada Lynx 4(f)(1) determination_JS-jzcomments.docx

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Caught a couple typos and had a couple thoughts/comments - attached, in TRACK CHANGES.

Thanks.

On Wed, Nov 15, 2017 at 12:59 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> take a look. I havent reviewed yet.
>
> You did fine responding directly to Matt. but please dont make promises :) JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> ---------- Forwarded message ----------
> From: **Shoemaker, Justin** <justin_shoemaker@fws.gov>
> Date: Wed, Nov 15, 2017 at 9:21 AM
> Subject: Canada lynx 4(f)(1) determination
> To: Marjorie Nelson <marjorie_nelson@fws.gov>, Jodi Bush <jodi_bush@fws.gov>
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> Justin Shoemaker
> Classification and Recovery Biologist
> U.S. Fish and Wildlife Service, Region 6
> Phone: 309-757-5800 x214
> Email: justin_shoemaker@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO
FWS/R6/ES

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APPROVED BY _____ DATE _____
Director, U.S. Fish & Wildlife Service

From:	Bush, Jodi
To:	Shoemaker, Justin
Cc:	Marjorie Nelson
Subject:	Re: Canada lynx 4(f)(1) determination
Date:	Wednesday, November 15, 2017 3:24:30 PM
Attachments:	2017 11 15 DRAFT Canada Lynx 4(f)(1) determination_JS-MTESO comments.docx

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comments.

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
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(406) 449-5225, ext.205

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Mountain-Prairie Region

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I think Yes JB

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APPROVED BY _____ DATE _____
Director, U.S. Fish & Wildlife Service

From: Bush, Jodi
To: Zelenak, Jim
Subject: Re: Canada lynx 4(f)(1) determination
Date: Wednesday, November 15, 2017 8:27:48 PM

---

thanks Jim. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
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(406) 449-5225, ext.205

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jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Jodi Bush; Marjorie Nelson; Justin Shoemaker
Subject:	DRAFT Lynx Update to the Court
Date:	Thursday, November 30, 2017 3:28:21 PM
Attachments:	2017 12 01 DOJ Draft WILDLIFE-#298505-v1- Lynx RP 7 17 Status Report CLEAN.doc

Although I'm a little out of the loop with what's going on with the 4(f)(1) and the RSOL's/HQ's review of the final SSA report and the 5-year review, we do have a 6-month update to the court due by the end of December. Given the above and the upcoming holiday, I've drafted the attached update based on my understanding of how things may unfold, using the last court update as a template.

Because of my uncertainty about this process, I thought I'd run this by you three before sending a draft to Dana.

Please edit as you see fit in TRACK CHANGES and send me your thoughts/concerns at your earliest convenience so I can get a draft to Dana allowing plenty of time for her to coordinate with DOJ and get the final update to the court by the Dec. 31 deadline.

Also wanted to let you know that I will be on annual leave after Christmas, returning to the office on Jan. 15 - the same day, coincidentally, that our determination (or formal recovery plan) is due to the court...

Cheers!

Jim

--

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
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JEFFREY H. WOOD
Acting Assistant Attorney General
SETH M. BARSKY, Chief
MEREDITH L. FLAX, Assistant Chief
TRAVIS ANNATOYN, Trial Attorney
New York Bar ID 4983730
U.S. Department of Justice
Environment & Natural Resources Division
Wildlife & Marine Resources Section
Ben Franklin Station, P.O. Box 7611
Washington, D.C. 20044-7611
(202) 514-5243 (tel)
(202) 305-0275 (fax)
travis.annatoyn@usdoj.gov

Attorneys for Federal Defendants

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF MONTANA
MISSOULA DIVISION

FRIENDS OF THE WILD SWAN, ROCKY MOUNTAIN WILD, et al.,	)	No. 13-cv-57-DWM
Plaintiffs, v.	)	DEFENDANTS' STATUS REPORT
DANIEL ASHE, U.S. FISH & WILDLIFE SERVICE, et al.,	)	
Defendants.	)	

Pursuant to the Court's order of June 25, 2014, Federal Defendants hereby submit the following status report on the United States Fish and Wildlife Service's ("Service") recovery planning for the Canada lynx under 16 U.S.C. § 1533(f) for

the period from July 1, 2017 to January 1, 2018. *See* ECF No. 30.

1. In March, 2015, the Service determined that a Species Status Assessment ("SSA") was necessary to guide recovery planning direction for the lynx Distinct Population Segment ("DPS"). From July, 2017 through December, 2017, the Service continued monthly calls or updates via electronic mail with Service field offices and with State and other Federal wildlife agency personnel. During this time period, the SSA Core Team continued work to finalize the SSA report based on peer and partner reviews and comments.
2. In October, 2017, the Core Team completed the Final SSA Report. The Final Report was submitted to the Service's Species Assessment Team, which relied on the report to draft the Canada Lynx (*Lynx canadensis*) 5-Year Review: Summary and Evaluation (5-year review).
3. On November 13, 2017, after internal Service and Solicitor review and concurrence from the other Regional Directors within the DPS range, the Regional Director for Region 6 signed the 5-year review (attached), which recommends delisting the Canada lynx DPS due to recovery.
4. On December XX, 2017, the Service's Acting Director signed the 4(f)(1) Determination Regarding Recovery Planning for the Canada Lynx (*Lynx canadensis*) (4(f)(1) determination; attached), indicating that development of a formal recovery plan at this time would not promote the conservation of

the lynx DPS.

5. On December XX, 2017, RSOL/DOJ briefed the Court on the Service's 5-year review recommendation and provided the Court copies of the Final SSA Report, the signed 5-year review, and the signed 4(f)(1) determination.

6. On December XX, 2017, the Service made the Final SSA Report, the signed 5-year review, and the signed 4(f)(1) determination available to the public via a news release and posting of the documents on its Canada lynx web page (https://www.fws.gov/mountain-prairie/es/canadaLynx.php).

DATED: {date}.

Respectfully submitted,

JEFFREY H. WOOD
Acting Assistant Attorney General
SETH M. BARSKY, Chief
MEREDITH L. FLAX,
Assistant Chief
/s/ *Travis Annatoyn*
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Attorneys for Federal Defendants

From: Bush, Jodi
To: Shoemaker, Justin; Marjorie Nelson
Cc: Zelenak, Jim
Subject: Re: DRAFT Lynx Update to the Court
Date: Wednesday, December 06, 2017 12:20:18 PM

I agree with Justin's edits but want to remind everyone that we have a court mandated timeline for a Final Lynx recovery plan of January 15, 2018. That is just over 4 weeks away. Has that been briefed up the chain ? Cause I can foresee a huge problem if we don't meet that timeline. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Tue, Dec 5, 2017 at 12:51 PM, Shoemaker, Justin <justin_shoemaker@fws.gov> wrote:

> My comments are attached.
>
> Justin Shoemaker
> Classification and Recovery Biologist
> U.S. Fish and Wildlife Service, Region 6
> Phone: 309-757-5800 x214
> Email: justin_shoemaker@fws.gov
>
> On Thu, Nov 30, 2017 at 4:28 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Although I'm a little out of the loop with what's going on with the 4(f)(1) and the RSOL's/HQ's review of the final SSA report and the 5-year review, we do have a 6-month update to the court due by the end of December. Given the above and the upcoming holiday, I've drafted the attached update based on my understanding of how things may unfold, using the last court update as a template.
> >
> > Because of my uncertainty about this process, I thought I'd run this by you three before sending a draft to Dana.
> >
> > Please edit as you see fit in TRACK CHANGES and send me your thoughts/concerns at your earliest convenience so I can get a draft to Dana allowing plenty of time for her to coordinate with DOJ and get the final update to the court by the Dec. 31 deadline.
> >
> > Also wanted to let you know that I will be on annual leave after Christmas, returning to the office on Jan. 15 - the same day, coincidentally, that our determination (or formal recovery plan) is due to the court...
> >
> > Cheers!
> >
> > Jim
> >
> > --
> > Jim Zelenak, Biologist
> > U.S. Fish and Wildlife Service
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601

(406) 449-5225 ext. 220
jim_zelenak@fws.gov

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO
FWS/R6/ES

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Boulevard
Lakewood, Colorado 80228-1807

DEC 1 1 2017

Memorandum

To: Director

From: Regional Director, Mountain-Prairie Region Noreen E. Walsh

Subject: 4(f)(1) Determination Regarding Recovery Planning for the Canada Lynx (*Lynx canadensis*)

The purpose of this memorandum is to make a determination under 16 U.S.C. § 1533(f)(1) that the development of a recovery plan for the contiguous United States distinct population segment (DPS) of the Canada lynx would not promote the conservation of the species. A recent multi-region 5-year review determined that the lynx DPS should be proposed for delisting pursuant to the Endangered Species Act (Act). The Service is required, by court order, to complete a recovery plan for the lynx DPS by January 15, 2018 unless the agency finds that such a plan will not promote conservation for the species.

Background

The Service listed the lynx DPS as a threatened species under the Act in 2000 (65 FR 16052-16086). We originally designated critical habitat for the lynx on November 9, 2006 (71 FR 66008), revised critical habitat on February 25, 2009 (74 FR 8616), then revised critical habitat again on September 12, 2014 (79 FR 54782). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court Montana 2014a, p. 8). On June 25, 2014, that court ordered the Service to complete a recovery plan by January 15, 2018 "...unless the Service finds that such a plan will not promote the conservation of the [lynx]" (U.S. District Court Montana 2014b, p. 2).

The Service listed the lynx DPS as threatened in 2000 because of the potential for impacts to lynx habitat conditions and prey populations due to regulatory mechanisms on Federal lands that did not provide sufficient certainty that lynx habitats, lynx populations, and prey populations would be adequately conserved in light of potential threats (65 FR 16052-16086). Federal land management plans, at that time, allowed for forest management practices that could potentially reduce lynx habitat on a population level scale, thereby creating a future risk to the species' existence in the DPS.

In coordination with Regions 1, 3, 5, and 6, the Service recently completed a 5-year status review that recommends delisting the lynx DPS (Canada Lynx 5-Year Review 2017, entire). Our status review was informed by a comprehensive Species Status Assessment (SSA) Report that summarizes the best available scientific information on the current status and likely future viability of the DPS (SSA Report, entire). The peer and partner reviewed SSA Report provides the scientific basis for the 5-year review.

As we stated in the 5-year review, "In light of potential threats considered at the time of listing, lynx conservation measures and habitat management guidance adopted by the U. S. Forest Service (USFS) and the Bureau of Land Management (BLM), via formally amended or revised management plans or conservation agreements with the Service, have substantially addressed the conservation of lynx habitats and populations and snowshoe hare habitat (SSA Report, p. 4)." (Canada Lynx 5-Year Review 2017, p. 5). All five geographic units that currently support resident lynx populations are expected to continue to do so through mid-century (2050) (SSA Report, p. 236). Our analyses, as informed by expert input, suggest that resiliency will likely be sufficient to sustain species persistence of resident lynx through mid-century in all or most of the five geographic units that currently support them (SSA Report, p. 236). At mid-century, we expect lynx to retain a wide geographical distribution of populations, maintaining redundancy within the DPS (SSA Report, p. 236). Should lynx populations in each geographic unit become smaller and more patchily distributed, reduced genetic health and/or adaptive capacity would be expected; however, we have no information to suggest reduced representation would be a DPS-level concern at mid-century (SSA Report, chapter 6). Therefore, we concluded in the 5-year review that the lynx DPS may not meet the definition of a threatened species (Canada Lynx 5-Year Review 2017, p. 6).

Recommendation

Section 4(f)(l) of the Act requires the Service to develop and implement recovery plans for species listed as endangered or threatened, "unless [the Service] finds such a plan will not promote the conservation of the species." According to the 2004 draft revised Recovery Planning Guidance jointly developed by the Service and the National Marine Fisheries Service, acceptable justifications for an exemption from having a recovery plan include: (1) delisting is anticipated due to extinction or listing error; (2) the species' historic and current ranges occur entirely under the jurisdiction of other countries; and, (3) other circumstances not easily foreseen, but in which the species would not benefit from a recovery plan.

For the lynx DPS, we are seeking concurrence that preparation of a recovery plan will not contribute to the conservation of the lynx DPS as defined by the Act, and that exemption from recovery planning efforts for the lynx DPS is warranted under reason (3) above. The "other circumstance" in this case is our recommendation to delist the lynx DPS due to recovery as described in the lynx DPS 5-year review (Canada Lynx 5-Year Review 2017, entire). The lynx DPS may no longer meet the definition of a threatened species. A proposed delisting rule should be prepared by the Service.

If, during the rulemaking process on the recommendation to delist the DPS, the Service determines that lynx should remain listed, the Service would reconsider the need to complete a recovery plan. Presently, the Service determines under 16 U.S.C. § 1533(f)(1) that a recovery plan would not promote conservation of the species and this determination will fulfill the Service's obligations under the 2014 Court Order.

APPROVED BY James W. Kurth DATE 12/20/17

Deputy Director
for the U.S. Fish and Wildlife Service
Exercising the Authority of the Director
for the U.S. Fish and Wildlife Service

Canada Lynx
(Lynx canadensis)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Mountain-Prairie Region
Lakewood, Colorado

5-YEAR REVIEW
Canada lynx (*Lynx canadensis*) – Contiguous U.S. Distinct Population Segment (DPS)

GENERAL INFORMATION

Methodology Used to Complete the Review:

In accordance with section 4(c)(2) of the Endangered Species Act (ESA), the purpose of a 5-year review is to assess each threatened and endangered species to determine whether its status has changed since the time of its listing, or its last status review and whether it should be classified differently or removed from the list of threatened and endangered species. The U.S. Fish and Wildlife Service (Service) evaluated the biology and status of the contiguous United States (U.S.) distinct population segment (DPS) of the Canada lynx as part of a Species Status Assessment (SSA) to inform this 5-year review and, if needed, recovery planning. The SSA Report was written by the Canada Lynx Species Status Assessment Team (Lynx SSA Team), which consists of a Core Team of Service biologists who work on lynx issues across the DPS range and an SSA Framework Implementation Team of Service and U.S. Geological Survey staff who have developed and advanced the SSA framework. The SSA Report represents the Service's evaluation of the best available scientific information, including the formally-elicited professional judgments and opinions of recognized lynx experts. The SSA Report underwent independent peer and partner review before being used as the scientific basis to support a decision making process involving Service Regions 1, 3, 5, and 6 regarding the recommendation presented in this 5-year review.

Region 6 is the lead region for this action in coordination with Regions 1, 2, 3, and 5. The lead field office (FO) is the Montana Ecological Services FO, with support from the Maine, Minnesota, Northern Idaho and Western Colorado Ecological Services FOs.

Background:

Listing History

The Service listed the lynx DPS as a threatened species under the ESA in 2000 because of the potential for impacts to lynx habitat conditions and the availability of snowshoe hare and other prey populations within the lynx DPS and existing regulatory mechanisms on Federal lands, at that time, did not provide sufficient guidance for the conservation of lynx habitats and populations or snowshoe hare habitat in light of potential threats (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (i.e., the DPS is recovered or no longer warrants ESA protections; U.S. District Court MT 2014b, p. 2). We published the initiation of the 5-year review in the Federal Register on April 18, 2007

(72 FR 19549), and additionally published a news release announcing initiation of a 5-yr review on January 13, 2015.

We completed the SSA Report to summarize the best available scientific information on the current status and likely future viability of the DPS. The SSA provides the scientific basis for this 5-year review.

REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy in the 2000 Listing

The Service listed lynx in the contiguous United States as a DPS because of differences in the management of lynx and lynx habitats across the international boundary with Canada (meeting discreteness criteria in the DPS policy) and because of the climatic, vegetative, and ecological differences in lynx habitat compared to the northern parts of the species' range in Canada and Alaska (meeting significance criteria) (65 FR 16052; 68 FR 40076; 72 FR 1186).

Updated Information and Current Species Status

Summary of SSA Results:

In the SSA, we describe the current and future viability of the lynx DPS in terms of resiliency, redundancy, and representation. Resident lynx populations persisted historically and continued to persist in four of the six geographic units evaluated in the SSA (Unit 1 (Northern Maine), Unit 2 (Northeastern Minnesota), Unit 3 (Northwestern Montana/Northeastern Idaho), and Unit 4 (North-central Washington)) (SSA Report, p. 235). Based on verified records, it is uncertain if the Greater Yellowstone Area (Unit 5) historically supported a persistent resident lynx population and it currently appears not to support resident lynx (SSA Report, p. 235). Available information also suggests that Colorado (Unit 6) did not historically support persistent lynx presence; however, a resident population has persisted there for more than a decade since the 1999-2006 release of 218 Canadian and Alaskan lynx in the San Juan Mountains (SSA Report, p. 235).

Considering the available information, we found no reliable information that the current distribution and abundance of resident lynx in the contiguous United States are substantially reduced from historical conditions (SSA Report, p. 235). In fact, because of the introduction of lynx in Colorado and anthropogenically influenced lynx abundance in Maine, there may be more resident lynx currently in the DPS range than occurred historically (SSA Report, pp. 228, 229). This suggests historical and current resiliency among lynx populations in the DPS. The current broad distribution of resident lynx in large, geographically discrete areas (redundancy) makes the DPS invulnerable to extirpation caused by a single catastrophic event (SSA Report, pp. 106, 235). Because we lack information that formerly persistent lynx populations have been lost from any large areas, it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels (SSA Report, pp. 106, 235). As a result of the current population in Colorado, redundancy in the DPS is likely greater, at least temporarily, now than it was historically (SSA Report, p. 235). Similarly, resident lynx remain broadly distributed across the

range of habitats that have supported them historically, suggesting maintenance of the breadth and diversity of ecological settings occupied within the DPS range (representation) (SSA Report, p. 235).

Additionally, observed high rates of dispersal and gene flow and therefore generally low levels of genetic differentiation across most of the lynx's range, including the DPS, suggest the past and recent genetic health of lynx populations in the DPS (representation) (SSA Report, section 2.1). Because there are no indications of significant loss of, or current stressors to, the genetic health or adaptive capacity of lynx populations in the DPS, we find that the current level of representation within the DPS does not appear to indicate a decrease from historical conditions (SSA Report, pp. 107, 230).

We conclude that resident lynx populations are very likely to persist in all five units that currently support them (Units 1 to 4 and 6) in the near term (2025) and likely to persist in those five units at mid-century (2050) (SSA Report, p. 236). We have low confidence in assessing the risk to DPS populations beyond 2050 (SSA Report, p. 236). Therefore, we consider 2050 as the foreseeable future for this 5-year review. Nonetheless, we expect lynx populations in each geographic unit to become smaller and more patchily distributed in the future (2050 and beyond) due largely to projected climate-driven losses in habitat quality and quantity and related factors (SSA Report, p. 236). However, the timing, rate, and extent of habitat decline due to projected climate warming and corresponding effects to lynx populations all are highly uncertain (SSA Report, p. 236). That said, smaller, more isolated populations would be less resilient and more vulnerable to demographic and environmental stochasticity and genetic drift and therefore at higher risk of extirpation (SSA Report, p. 236). Despite some reduced resiliency, we conclude that resident lynx populations are likely to persist through mid-century in the geographic units that supported them historically (Units 1 to 4); with the corresponding maintenance of redundancy and representation in the DPS over that time span (SSA Report, p. 236). Although the SSA report also discusses the future out to 2100, predictions that far into the future are highly uncertain (SSA Report, p. 236), and beyond what we consider to be reasonably foreseeable.

Consideration of the Five 4(a)(1) Factors:

Through our SSA analysis, we have evaluated the effects of all factors identified in section 4(a)(1) of the ESA. In the SSA we focused on the influences identified as having the potential to exert population and DPS-level impacts on lynx and lynx habitats (SSA Report, chapter 3). Those anthropogenic influences include climate change (Factor E), vegetation management (Factor A), wildland fire management (Factor A), and habitat loss and fragmentation (Factor A). We also considered other potential stressors such as trapping (Factor B), and disease and predation (Factor C). Additionally, we considered how each of the above influences is ameliorated or exacerbated by existing regulatory mechanisms (Factor D).

In using the SSA framework to analyze the scientific information, as documented in the SSA Report, we fully assess not only individual effects on the Canada lynx, but also their potential cumulative impacts. Specifically, we incorporate cumulative effects into our analysis when we characterize the current and future conditions for each population, which we do both individually and cumulatively. Our analysis described the ways in which anthropogenic and natural factors

singly and collectively affect the habitat and/or demographics needed by individuals and populations. Because the SSA framework considers not just the presence of the factors but also the degree to which they collectively influence the species' viability, our assessment integrates the cumulative impacts of stressors.

In light of potential threats considered at the time of listing, lynx conservation measures and habitat management guidance adopted by the U. S. Forest Service (USFS) and the Bureau of Land Management (BLM), via formally amended or revised management plans or conservation agreements with the Service, have substantially addressed the conservation of lynx habitats and populations and snowshoe hare habitat (SSA Report, p. 4).

Synthesis (Application of SSA Results to ESA Classification)

As defined by the ESA, an endangered species is any species that is "in danger of extinction throughout all or a significant portion of its range." In the SSA Report, we evaluated the best available scientific information regarding the current and predicted future condition of the lynx DPS to describe its viability and how it may change over time (2025, 2050, and 2100). We assess the viability of the lynx DPS by evaluating its ability to maintain a sufficient number and distribution of viable populations to withstand environmental stochasticity (resiliency), catastrophes (redundancy), and changes in its environment (representation) into the future. Ultimately, we compare our evaluation of the DPS' risk of extinction against the definitions of an endangered or threatened species as defined by the ESA.

As stated above. the Service listed the lynx DPS as threatened in 2000 because of the *potential for impacts* to lynx habitat conditions and the availability of prey populations within the lynx DPS and existing regulatory mechanisms on Federal lands, *at that time*, did not provide sufficient guidance for the conservation of lynx habitats and populations or prey habitat in light of *potential threats* (65 FR 16052-16086). Federal lands management plans, at that time, allowed for forest management practices that could potentially reduce lynx habitat on a population level scale, thereby creating a future risk to the species existence in the DPS. Nearly all Federal land management plans throughout the DPS have since been revised to include science- and research-based measures and management practices consistent with lynx conservation, thereby greatly reducing the risk of future population scale habitat deterioration on Federal lands.

The apparent long-term (historical and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1 to 4), the current persistence of lynx in one of the units (Unit 6), and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historical conditions suggest the historical and recent resiliency to stochastic events of lynx populations in the DPS (SSA Report, pp. 107, 230). The large sizes and broad distributions of the geographic units occupied by resident lynx populations likewise indicate historical and current redundancy in the DPS sufficient to reduce the possibility of extirpation from catastrophic events (SSA Report, pp. 230, 235). There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not suggest a decrease from historical conditions (SSA Report, p. 230). Due to the current resiliency, redundancy, and

representation of the lynx DPS, we conclude that the risk of extinction (in this case, extirpation of all resident lynx populations in the DPS) is low, such that the DPS currently is not in danger of extinction throughout all of its range and, therefore, does not meet the definition of an endangered species.

Having determined that the lynx DPS is not endangered, we next compare the status of the DPS to the definition of a threatened species. Under the ESA, a threatened species is any species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The foreseeable future refers to the extent to which the Secretary can reasonably rely on predictions about the future in making determinations about the future conservation status of the species (U.S. Department of Interior, Solicitor's Memorandum, M-37021, and January 16, 2009). The key statutory difference between a threatened species and an endangered species is the timing of when a species may be in danger of extinction, either now (endangered species) or in the foreseeable future (threatened species). In the SSA, we considered the future condition of the lynx DPS out to 2025, 2050, and 2100 (SSA Report, chapter 5). It became apparent through discussions with lynx experts, in peer and partner reviews of the draft SSA Report, and among Service biologists and management that any future projections of lynx status beyond mid-century were complicated by a very high degree of uncertainty concerning the timing and extent of various stressors that may affect lynx and hare habitat and snow regimes, especially those related to projected future climate change (SSA Report, chapter 5.1). Therefore, in this evaluation, we identified mid-century (2050) as the foreseeable future because this time horizon gives us a higher degree of certainty in reasonably projecting the future condition of the lynx DPS.

As discussed in the SSA Report, resident lynx populations in all geographic units that currently support them are expected to be smaller and more fragmented and isolated in the future, and each geographic unit and the DPS as a whole will be less resilient in the future (SSA Report, pp. 173, 236). However, all five geographic units that currently support resident lynx populations (all units except the GYA) are expected to continue to do so through mid-century (2050) (SSA Report, p. 236). Our analyses, as informed by expert input, suggest that resiliency will likely be sufficient to foster persistence (i.e., preclude extirpation) of resident lynx through mid-century in all or most of the five geographic units that currently support them (SSA Report, p. 236). At mid-century, we expect lynx to retain a wide geographical distribution of populations, maintaining redundancy within the DPS (SSA Report, p. 236). Should lynx populations in each geographic unit become smaller and more patchily distributed, reduced genetic health and/or adaptive capacity would be expected; however, we have no information to suggest reduced representation would be a DPS-level concern at mid-century (SSA Report, chapter 6). Therefore, we conclude that the risk of extinction (extirpation of the DPS) by 2050 is sufficiently low that the lynx DPS is not likely to become endangered throughout all of its range within the foreseeable future and therefore does not meet the definition of a threatened species.

Recovery Criteria

Recovery Plan or Outline: There is no recovery plan for the Canada lynx DPS, and therefore recovery criteria have not been developed. The Service completed a Recovery Outline on September 14, 2005, which provided preliminary recovery objectives and actions based on our

understanding, at that time, of current and historical lynx occurrence and lynx population dynamics in the contiguous United States DPS. Lynx conservation measures and habitat management guidance adopted by the USFS and the BLM have substantially addressed the potential threats considered at the time of listing (and the time of the recovery outline) to the maintenance of lynx DPS habitat conditions and the availability of snowshoe hare and other prey populations (SSA Report, p. 4). Additionally, our understanding of lynx biology, ecology, effects of stressors into the foreseeable future, and historic and current occupancy in the contiguous United States has improved in the 12 years since the Recovery Outline was drafted, rendering some of the preliminary recovery objectives and actions in the 2005 Recovery Outline obsolete. Finally, as described above, the lynx DPS no longer meets the definition of a threatened species; therefore, recovery criteria are not necessary.

RESULTS

Recommended Classification: After assessing the best available information, we conclude that the Canada lynx DPS is not in danger of extinction throughout all of its range or likely to become so in the foreseeable future; that is, it is not an endangered species throughout all of its range or a threatened species throughout all of its range. We recommend removing the Canada lynx DPS, currently listed as threatened, from the list of threatened and endangered species.

____ **Downlist to Threatened**
____ **Uplist to Endangered**
__x_ **Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
__x_ *Recovery*
____ *Original data for classification in error*
____ **No change is needed**

New Recovery Priority Number *(indicate if no change; see Appendix E)*:

Brief Rationale:

Listing and Reclassification Priority Number, if reclassification is recommended *(see Appendix E)*

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (Removal from list regardless of current classification) Priority Number:
__x__

Brief Rationale:

RECOMMENDATIONS FOR FUTURE ACTIONS – Proceed with a proposed rule to remove the Canada lynx DPS from the list of threatened and endangered species.

REFERENCES – A large part of the lynx SSA involved seeking expert input on lynx biology, stressors, and current and future condition of the DPS. We describe the expert elicitation process and the experts involved in our Canada Lynx Expert Elicitation Workshop Final Report (Service 2016, entire). A draft SSA Report went through an extensive review process with peer reviewers, tribes, State agencies, and Federal agencies within the range of the lynx DPS. The final SSA Report has been revised in response to the reviews, comments, and suggestions of 5 independent peer reviewers, 11 State wildlife and natural resources management agencies, and 3 other Federal agencies.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Canada Lynx (*Lynx canadensis*) –
Contiguous U.S. Distinct Population Segment (DPS)

Current Classification:

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
__x__ Delist
____ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By:

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, U.S. Fish and Wildlife Service

Approve Noreen E Walsh Date 11/13/17

The Lead Region must ensure that other regions within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. Written concurrence from other regions is required.

Species Status Assessment

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment



Photo by Keith Williams

Version 1.0 - Final
October 2017

U.S. Fish and Wildlife Service
Regions 1, 3, 5 and 6

Recommended Citation

U.S. Fish and Wildlife Service. 2017. Species Status Assessment for the Canada lynx (*Lynx canadensis*) Contiguous United States Distinct Population Segment. Version 1.0, October, 2017. Lakewood, Colorado.

Credits

This SSA report was produced by the Canada Lynx Species Status Assessment Team (Lynx SSA Team), which consists of a Core Team of Service biologists who work on lynx conservation across the DPS range and an SSA Framework Implementation Team of Service and U.S. Geological Survey staff who have developed and advanced the SSA framework.

U.S. Fish and Wildlife Service Lynx SSA Core Team

Jim Zelenak (Lead), Region 6, Montana Ecological Services Field Office: Chapters/sections - Executive Summary, 1, 2, 3.1, 3.4, 6, and Units 3 and 5
Mark McCollough (Co-lead), Region 5, Maine Ecological Services Field Office: Sections - 3.2, 3.3, 3.5, and Unit 1
Kurt Broderdorp, Region 6, Western Colorado Ecological Services Field Office: Unit 6
Bryon Holt, Region 1, Northern Idaho Ecological Services Field Office: Unit 4
Tamara Smith, Region 3, Minnesota-Wisconsin Ecological Services Field Office: Unit 2

All Core Team members participated in development of conceptual models and reviewed and provided comments/edits on other sections of the SSA report. All members also helped identify and contact lynx expert panelist candidates and other subject matter experts and contributed to expert elicitation and the report of the Expert Elicitation Workshop (see Acknowledgments).

SSA Framework Implementation Team

Heather Bell, USFWS Headquarters, Ecological Services, Division of Restoration and Recovery
Mary Parkin, USFWS Region 5, Endangered Species Recovery Coordinator
Justin Shoemaker, USFWS Region 6, Classification and Recovery Biologist
Jonathan Cummings, USGS - Patuxent Wildlife Research Center, Research Ecologist

The Framework Implementation Team (FIT) developed and facilitated the expert elicitation process. J. Cummings compiled, analyzed, graphed, and summarized the information generated via expert elicitation and created, with Core and FIT input, conceptual models presented in section 1.3. All FIT members contributed to the Executive Summary and sections 1.2 and 1.3, and all provided technical review and editing of other parts of the report.

Administrative and Technical Support: Marigaye Bissell, Barbara Chavez, Kaimy Marks, and Karen Newlon, Montana Ecological Services Field Office.

Acknowledgments

This report relies heavily on the input and professional opinions provided by a panel of 10 recognized lynx experts and captured during a formal Expert Elicitation Workshop held in Bloomington, Minnesota, October 13-15, 2015. Several other recognized lynx experts from Canada and the contiguous United States were invited but unable to participate. The workshop also was supported by and benefitted from the participation and presentations of other recognized experts in the fields of snowshoe hare ecology, lynx genetics, forest ecology, climate change modeling, and Federal lynx habitat management.

Canada Lynx Expert Panel Members (alphabetically)

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The Canada Lynx Expert Elicitation Workshop Report can be found here:

https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/2016%2004%2018%20FINAL%20Lynx%20SSA%20EE%20Workshop%20Report%202%20jzeds.pdf

Report appendices, expert presentations, and other supporting materials can be found under the “Species Status Assessment (SSA)” tab at:

https://www.fws.gov/mountain-prairie/es/canadaLynx.php

This report also relies heavily on the Interagency Lynx Biology Team's *Canada Lynx Conservation Assessment and Strategy*, 3rd Edition, August 2013:

Interagency Lynx Biology Team. 2013. Canada lynx conservation assessment and strategy. 3rd edition. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication R1-13-19, Missoula, MT. 128 pp. http://www.fs.fed.us/biology/resources/pubs/wildlife/LCAS_revisedAugust2013.pdf.

All Lynx SSA Core Team members participated in development and review of the revised LCAS.

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Executive Summary

This report presents the results of a species status assessment (SSA) for the contiguous United States distinct population segment (DPS) of Canada lynx (*Lynx canadensis*). The report represents the U.S. Fish and Wildlife Service's (Service's) evaluation of the best available scientific information, including the formally elicited professional judgments and opinions of recognized lynx experts. Based on this information, we (1) describe the ecological requirements and population dynamics of the species; (2) evaluate the historical and current condition of lynx populations in the DPS and the factors that appear to have influenced them; and (3) assess the DPS's near-term (at year 2025), mid-term (year 2050), and longer-term (year 2100) viability. This final SSA has been revised in response to the reviews, comments, and suggestions of 5 independent peer reviewers, 11 State wildlife and natural resources management agencies, and 3 other Federal agencies.

Background

The Canada lynx is a North American boreal forest carnivore whose populations are strongly tied to its primary prey, the snowshoe hare (*Lepus americanus*). Both species occur primarily in the extensive boreal spruce-fir forests of Canada and Alaskan; however, the southern margins of both their ranges extend into the northern contiguous United States. The Service designated lynx in the Lower 48 States as a DPS because of differences in the management of lynx and lynx habitats across the international boundary with Canada and because of the climatic, vegetative, and ecological differences between lynx habitat at the southern extent of its range in the contiguous United States compared to the northern range in Canada and Alaska. The Service listed the DPS as threatened under the Endangered Species Act (ESA) in 2000 because of the inadequacy, at that time, of regulatory mechanisms on some Federal lands to provide for the conservation of lynx habitats and populations (see section 3.1.1). This SSA does not reconsider the designation of the DPS or its listing status under the ESA, which are Service policy decisions. Instead, it provides the scientific basis for the statutorily required 5-year status review for the DPS and other decisions the Service is required to make in accordance with the ESA.

In this SSA, we evaluate the current and possible future conditions for lynx in 6 geographic units within the DPS range that currently support or recently supported resident lynx. The units are distributed from Maine to Washington and south along the Rocky Mountains to western Colorado (fig. 1). Units 1 (Northern Maine), 2 (Northeastern Minnesota), 3 (Northwestern Montana/Northeastern Idaho), and 4 (North-central Washington) historically supported and currently support resident lynx populations. Based on verified records, it is uncertain whether Units 5 (Greater Yellowstone Area [GYA]) and 6 (Western Colorado) historically supported persistent populations or if they supported resident lynx only ephemerally (see section 2.3.2.2). Combined, the 6 units encompass over 131,000 km^2 (about 50,640 mi^2) of occupied or potential lynx habitat and represent roughly the southern 2 percent of the species' breeding distribution (98 percent occurs in Canada and Alaska). Land ownership varies among the units, with private

lands accounting for most of Unit 1; a mix of Federal, State and private lands in Unit 2; and predominantly Federal lands in the 4 western units (see table 2, chapter 1 for additional details on unit sizes and land ownership).

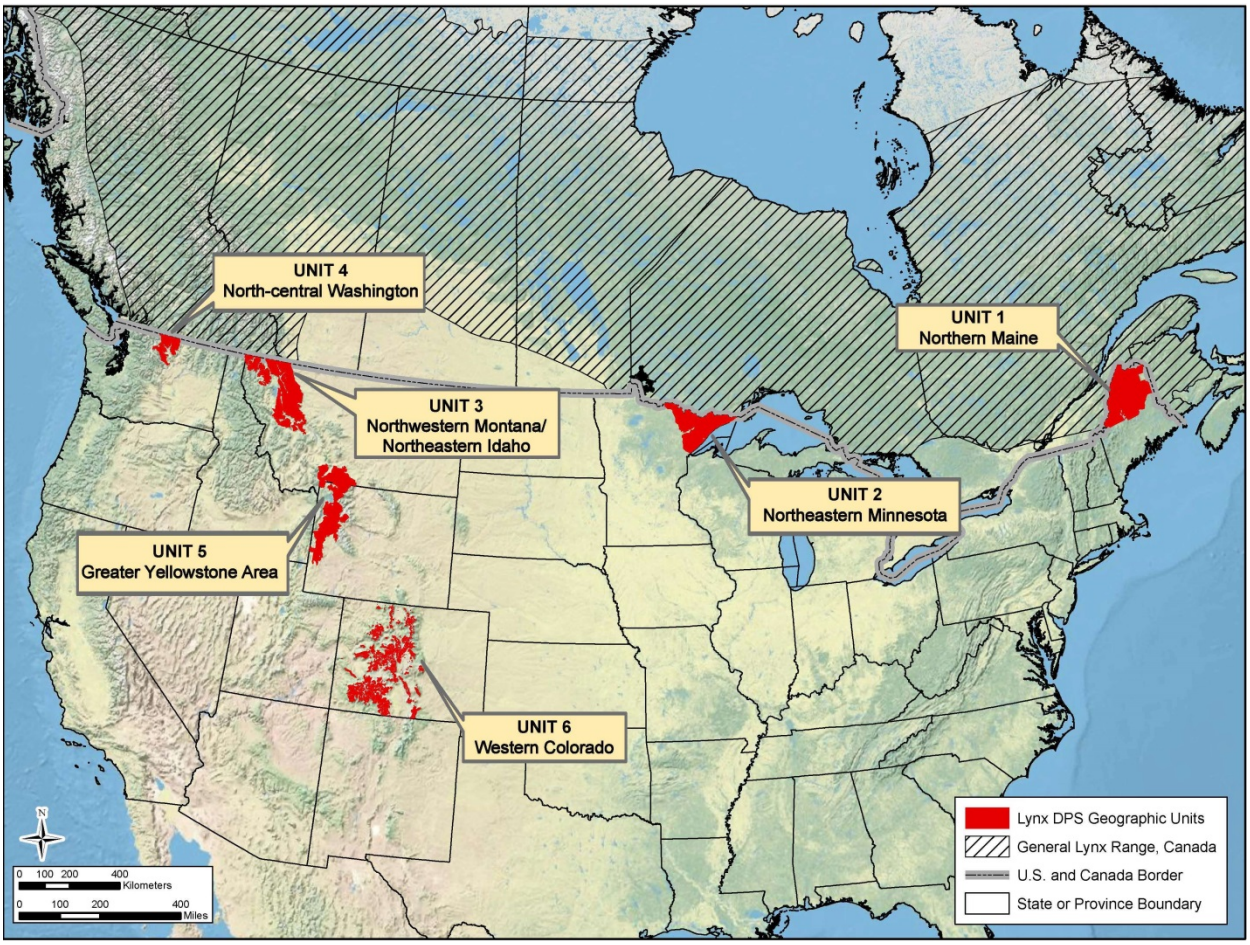


Figure 1. Six geographic units within the range of the contiguous United States distinct population segment of Canada lynx (*Lynx canadensis*).

The lynx is a habitat and prey specialist that requires dense boreal and subalpine forests that support abundant snowshoe hares, which typically constitute greater than 90 percent of the lynx's year-round diet. Lynx and hares are most abundant in areas with long winters and persistent deep, powdery snow. The lynx has evolved morphological adaptions - long legs and exceptionally large paws - which in snowy conditions are thought to confer a competitive advantage over other terrestrial hare predators and allow lynx to occupy habitats that are unavailable, at least seasonally, to some of its potential competitors. The DPS occurs at the southern margin of the species' range, where boreal forest habitats and thus lynx are, in most places, naturally less abundant and generally more patchily-distributed than in the core of the species' range in Canada and Alaska. Maintaining connectivity between the DPS and lynx populations in Canada is thought to be important. However, the extent to which DPS populations may depend on immigration of lynx from Canada remains uncertain.

Our understanding of lynx biology has improved substantially since the DPS was proposed for listing in 1998. For example, analysis of historical trapping data indicated that many lynx records in the contiguous United States coincided with the intermittent (roughly decadal) mass dispersal ("irruptions") of lynx from Canada into the northern United States when hare populations in Canada underwent steep cyclic declines. During these events, particularly the unprecedentedly large irruptions of the early 1960s and early 1970s, hundreds to thousands of lynx dispersed south into both suitable and unsuitable habitats in the northern United States. In suitable habitats, immigrants may have contributed to the demographic and genetic health of resident populations; in unsuitable habitats, dispersing lynx occurred only temporarily and disappeared relatively quickly from areas that are not capable of supporting resident populations over the long-term. Research and monitoring conducted by State, Federal, and Tribal agency partners and academic institutions also have refined our understanding of lynx habitat requirements and associations, distributions, demography, and potential stressors throughout the DPS range (see Summary of Findings, below, and chapters 2-4).

SSA Framework

The SSA framework considers a species' life history and ecological requirements to understand how the species maintains itself over time. Therefore, we evaluated the ecological requirements of individual lynx and populations and the current and possible future conditions for resident lynx populations in each geographic unit to assess the viability of the DPS. The SSA uses the conservation biology principles of resiliency, redundancy, and representation (the "3 Rs") as the framework for assessing current and future conditions. Resiliency describes the ability of populations and species to withstand stochastic events, redundancy describes a species' ability to withstand catastrophic events, and representation describes a species' ability to adapt to long-term changes in the environment (see sections 1.2 and 1.3). For lynx, the factors capable of influencing the 3 Rs that we evaluate in this SSA include the adequacy of existing regulatory mechanisms (the factor for which the DPS was listed); climate change, vegetation management, wildland fire management, and habitat loss and fragmentation (the factors considered by the Interagency Lynx Biology Team [ILBT] to have the potential to exert population-level effects on the DPS); and other factors that could influence the continued ability of particular geographic units to support resident lynx.

Uncertainties and Assumptions

Several sources of uncertainty had to be accounted for in our analysis, including limited data on lynx population sizes, trends, and other important demographic parameters in the DPS; the influence of lynx immigration from Canada on the persistence of the DPS; the effectiveness of habitat management efforts; and the potential effects of competition. We similarly lack consistent habitat and demographic information for snowshoe hares throughout much of the DPS range. Given the emerging role of climate change as a stressor, uncertainties about the timing, rate, and magnitude of projected future impacts to hares; boreal, subalpine, and montane forests; and snow quality, depth, and persistence constrain our ability to precisely predict effects on lynx populations and habitats. To account for these uncertainties in our

analysis, we identified a number of critical assumptions based on the scientific literature and input provided by the lynx experts we consulted (see section 1.4).

As part of our evaluation of the DPS's viability, we asked a panel of 10 lynx experts to provide their opinions on the likelihoods that each geographic unit would support resident lynx populations in the short-term (at year 2025), mid-term (at year 2050) and longer-term (at year 2100). The level of uncertainty regarding the viability of the DPS and each of the factors that may influence it increases the farther into the future we (and the experts we consulted) try to look, and this uncertainty greatly reduces confidence in projections, particularly beyond mid-century. The output from this expert elicitation process (summarized below and presented in detail in chapter 5) remains the experts' best professional judgment, and readers should consider the inherent limitations and substantial uncertainties in expert responses, particularly over longer time periods (see also section 1.4 and chapter 5).

Summary of Findings

Much irresolvable uncertainty remains regarding the historical distributions and sizes of resident lynx populations in the contiguous United States. Several small populations may have been extirpated from some areas within or adjacent or peripheral to the geographic units we assess and a recent fire-driven decline in lynx numbers in Unit 4 seems likely. However, we find no compelling evidence, based on verified historical records, of major range contraction or dramatic declines in the number of resident lynx in the DPS as a whole (see section 2.3.2). In fact, there are currently more resident lynx in some parts of the DPS (Maine and Colorado) than likely occurred historically and, in those areas and in Minnesota, there are more resident lynx now than was suspected when the DPS was listed. Further, some areas suspected to have lost historical lynx populations may have been (and perhaps are now) naturally capable of supporting resident lynx only ephemerally or intermittently, as would be expected in marginal habitats at the southern periphery of the species' range under a metapopulation structure like that thought to govern DPS lynx populations (see sections 2.2 and 4.1).

Lynx conservation measures and habitat management guidance adopted by the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) via formally amended or revised management plans or conservation agreements with the Service have substantially addressed the singular threat for which the DPS was listed (the inadequacy of regulatory mechanisms when the DPS was listed; see section 3.1). Conservation efforts by State, Tribal, and other Federal agencies; conservation organizations; and some private landowners also have secured protection of lynx habitats and reduced a number of other potential stressors to lynx populations and habitats throughout the DPS range. Nonetheless, we and the experts we consulted expect that resident population sizes and distributions in the DPS will likely decline largely as a result of projected continued climate warming and associated impacts, which are likely to exacerbate the potential adverse effects of other stressors.

Although the timing and extent of climate-mediated impacts are uncertain, continued warming is expected to cause a northward and upslope contraction of the boreal forest, snow conditions,

and hare populations that support lynx, along with several other potential impacts (see section 3.2). This, in turn, will likely result in smaller, more fragmented, and increasingly isolated patches of habitat and smaller, more isolated lynx populations in the DPS that would be more vulnerable to stochastic demographic and catastrophic events and genetic drift. It also may improve conditions for other terrestrial hare predators, potentially resulting in increased competition and displacement of lynx from areas that currently support resident populations. Climate-driven increases in the frequency, size, and intensity of wildfires and forest insect outbreaks are also expected to continue, although we do not anticipate that such events alone would cause the permanent loss of breeding lynx populations in any geographic unit. We are aware of no management actions that could be expected to abate the projected long-term retreat of boreal forests, declining hare populations, and diminished snow conditions expected under continued climate warming.

Despite the anticipated long-term effects of climate warming and the effects of other potential stressors (see chapter 3), we and the experts we consulted expect that each of the 5 geographic units that currently supports resident populations (Units 1-4 and 6) individually has a high likelihood (80 to 98 percent based on median "most likely" expert projections; see table 1, below, and section 5.2, figs. 10-13 and 15) of continuing to do so at year 2025. Experts similarly indicated high likelihoods (70 to 90 percent) that those units will continue to support resident populations through 2050, albeit in reduced numbers and distributions. Experts projected that only Unit 3 has a high (78 percent) likelihood of supporting resident lynx by 2100; all other geographic units individually were deemed to have a 50 percent or greater likelihood of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century; however, all experts expressed great uncertainty in their projections for that time period (see section 1.4 and the introduction to chapter 5).

Table 1. Summary of expert opinion regarding the likelihood that individual geographic units will continue to support resident lynx populations in the future[1].

Geographic Unit	Year					
	2025		2050		2100	
	Probability of Persistence (%)[2]	Range (%)[3]	Probability of Persistence (%)	Range (%)	Probability of Persistence (%)	Range (%)
1	96	80-100	80	65-95	50	40-80
2	96	88-100	80	60-90	35	10-60
3	98	95-100	90	70-100	78	50-90
4	80	60-95	70	30-80	38	5-50
5	52	10-70	35	15-60	15	5-50
6	90	60-100	80	50-85	50	20-70

[1]We asked 10 recognized lynx experts to provide their estimates of the probability that resident lynx populations or subpopulations would persist in each geographic unit, even if reductions in lynx numbers and distributions were anticipated (i.e., the probability that resident lynx would *not* be functionally extirpated from the unit).
[2]Median "most likely" probabilities of persistence provided by 10 lynx experts for each geographic unit considering the current status of lynx populations and current and likely future stressors to those populations. Green = 68–100% median probability of persistence; Yellow = 34–67% median probability of persistence; Red = 0–33% median probability of persistence.
[3]The full range of "most likely" probabilities of persistence provided by the 10 lynx experts.

Cumulatively, expert median “most likely” responses suggest a high (80 percent) likelihood that resident lynx populations will persist in all 5 units that currently support them at year 2025 and in at least 4 of the 5 units at 2050, and a moderate (just under 50 percent) likelihood that they will persist in all 5 units at 2050 (fig. 2, middle column; also see section 5.1). Over the longer-term, expert responses suggest a high (about 85 percent) likelihood that resident populations will persist in at least 2 of the 5 units at 2100 and a more than 50 percent likelihood they will persist in 3 units, but also a high (> 75 percent) likelihood that resident populations will be functionally extirpated from 2 of the 5 units by the end of the century (fig. 2).

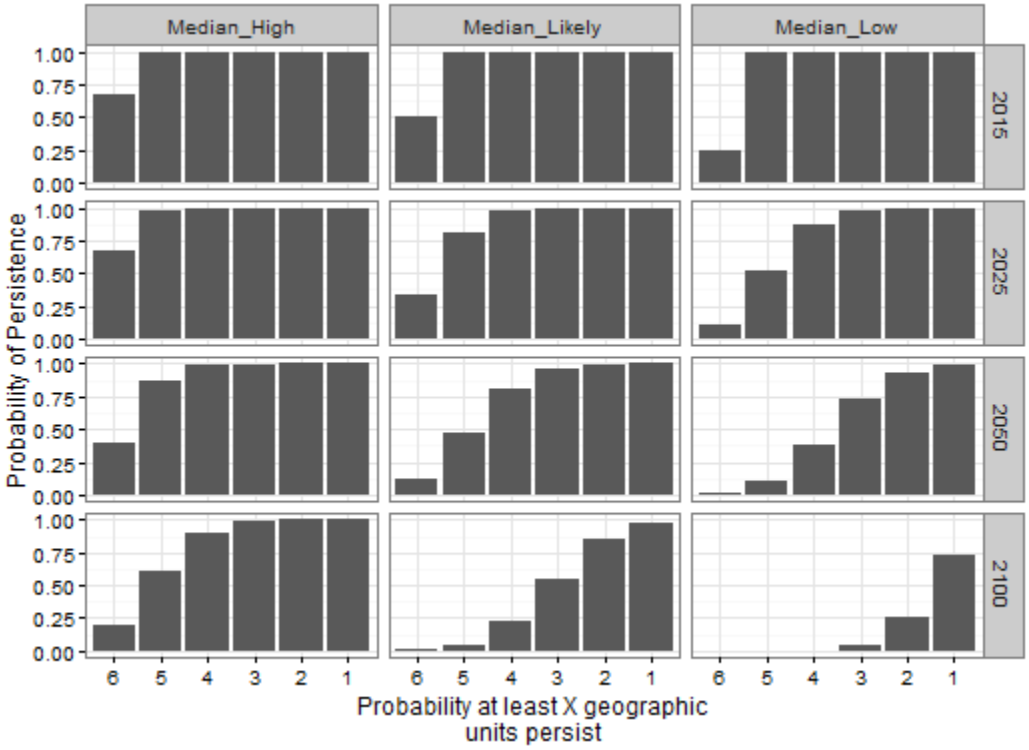


Figure 2. Cumulative probabilities that resident lynx populations will persist in at least a given number of geographic units over time (at years 2015 [current at time of expert elicitation], 2025, 2050, and 2100) based on experts’ predictions for individual geographic units. Experts’ “most likely” probabilities are summarized in the middle column; their highest (“better case”) and lowest (“worse case”) probabilities, representing uncertainty in their predictions, are summarized in the left and right columns, respectively. See section 5.1 for additional details on graph construction and interpretation.

Below we summarize lynx status in each geographic unit based on our understanding of conditions historically, at the time the DPS was listed, and currently, and considering expert opinions regarding potential population sizes and future persistence. See section 2.3.2 for a detailed assessment of historical and current lynx distribution across the DPS range and chapters 4 and 5, respectively, for detailed evaluations of current and possible future conditions in each geographic unit.

Unit 1 - Currently, northern Maine is thought to support many more resident lynx than likely occurred historically and many more than was known or suspected at the time the DPS was

listed, and recent information suggests that resident lynx may be expanding to the south of the core population area. This is due to the large amount and broad distribution of high-quality lynx and hare habitat that currently exists as a result of landscape-level clearcutting on private commercial timber lands in response to a major spruce budworm (*Choristoneura fumiferana*) outbreak in the 1970s and 1980s. These dense regenerating conifer stands are much more extensive than they are thought to have been historically under natural disturbance regimes. The State of Maine suggests that this unit currently may support 750-1,000 or more resident lynx. However, the extent of these high-quality stands probably peaked by 2010, and habitat quality is projected to decline in these stands over the next few decades as they age beyond 35-40 years post-harvest. Because a shift in forest management from clearcutting to partial harvesting that began in 1989 appears unlikely to maintain or recreate this extensive high-quality habitat, we expect lynx habitat and numbers to decline in this unit over the next several decades, perhaps to levels more consistent with likely historical conditions. We concur with the expert panel that the resident lynx population in this unit is very likely to persist at 2025 and at 2050. Over the longer-term (at 2100), we expect continued climate warming to reduce the amount and quality of lynx habitat in this unit and exacerbate other potential stressors (commercial and energy developments, changing forestry practices and land ownership patterns, etc.), further reducing lynx numbers and likely decreasing the population's resilience. Some climate models indicate substantial loss of boreal forest and favorable snow conditions under higher emissions scenarios, and this unit generally lacks potential elevational refugia that would support upslope movement of lynx habitats and populations. Therefore, we suggest that the likelihood that this unit will support a resident lynx population at 2100 may be somewhat lower than expert projections, although the timing and extent of climate-mediated habitat decline is highly uncertain. This geographic unit also may be the source of dispersing lynx that recently recolonized northern New Hampshire as well as several that temporarily established residency in northern Vermont. Some reproduction has been verified recently in both states, although neither was occupied when the DPS was listed, and resident lynx were thought to have been extirpated from New Hampshire.

Unit 2 - Northeastern Minnesota similarly supports many more resident lynx than was suspected when the DPS was listed (when it was unknown whether a resident population occurred there at all), although how the current population compares to historical conditions is uncertain. Trapping records indicate strongly cyclic increases in lynx abundance in this unit in the 1930s through 1970s in association with decadal irruptions of lynx dispersing south from Canada. Currently, Minnesota lynx experts suggest that the population in this unit likely fluctuates from 50 to 200 resident lynx, and we find no evidence that it historically supported a larger resident population or a more extensive distribution of habitat capable of doing so. We concur with the expert panel that the resident lynx population in this unit is very likely to persist at 2025 and at 2050. Over the longer-term (at 2100), we expect continued climate warming to reduce the amount and quality of lynx habitat in this unit, reducing lynx numbers and likely decreasing the population's resilience. Under higher emissions scenarios, some climate models project substantial loss of boreal forest and favorable snow conditions in this unit before the end of the century. Like Maine, this unit also lacks potential elevational refugia that would support upslope movement of lynx habitats and populations. Therefore, we suggest that the likelihood that resident lynx will persist in this

unit at 2100 may be somewhat lower than expert projections, although the timing and extent of climate-mediated habitat decline is highly uncertain.

Unit 3 - Recent research, monitoring, and habitat mapping refinements indicate that habitats capable of supporting resident lynx in this and other western geographic units are naturally less abundant and more patchily-distributed than was thought when the DPS was listed. For example, earlier estimates that western Montana supported 1,000 or more lynx were based on broad assumptions regarding habitat suitability and lynx distribution that are not supported by current understanding of lynx habitat requirements (see section 4.2.3). Currently, this unit is thought to be capable of supporting 200-300 resident lynx. How the current population compares to historical conditions is uncertain, but we find no evidence that this unit historically supported a larger resident population or a substantially broader distribution of habitat capable of doing so. Lynx habitats in this unit are naturally patchy and fragmented due to topography and elevational and moisture (aspect) constraints. We concur with the expert panel that resident lynx are very likely to persist in this unit at years 2025 and 2050, and likely to do so at 2100. Over the longer-term, we expect continued climate warming and associated impacts, perhaps especially increased wildfire activity, to reduce the amount and quality of lynx habitat in this unit, reducing lynx numbers and likely decreasing the population's resilience. Although the timing and extent of climate-mediated habitat decline is highly uncertain and fire-driven habitat loss typically would be temporary, wildfire size, frequency, and intensity have increased in this unit over the past few decades, and this pattern is expected to continue with projected climate warming.

Unit 4 - Atypically large, frequent, and intense wildfires over the past few decades have impacted over a third of the lynx habitat in north-central Washington, perhaps substantially more after additional fires in 2017. Because of this, the number of resident lynx in this unit is likely lower than it was historically and when the DPS was listed. Based on estimates of lynx carrying capacity, this unit may have been capable of supporting roughly 50-60 resident lynx prior to large fires beginning in the early 1990s. Recent habitat evaluations suggest it currently may be capable of supporting only about 30-35 lynx, with the decline due to fire-driven habitat losses. Although these losses are expected to be temporary, additional fires in this unit before previously burned areas recover (10-40 years post-burn) would further reduce lynx numbers and make this geographic unit more vulnerable to extirpation. Because of these habitat impacts, limited demographic information, and remaining uncertainties (e.g., immigration/emigration rates, changes in snowpack, disease, lynx population status and impacts of trapping in southern British Columbia, and habitat corridor stability between British Columbia and this unit), the Washington Department of Fish and Wildlife recently submitted, and the State Fish and Wildlife Commission adopted, a proposal to uplist lynx from threatened to endangered within the State. Nonetheless, we concur with the expert panel that the resident lynx population in this unit is very likely to persist at years 2025 and 2050. Over the longer-term (2100), we expect continued climate warming to reduce the amount and quality of lynx habitat in this unit, further reducing lynx numbers and likely decreasing the population's resilience. Therefore, we concur with experts that this unit has a relatively lower likelihood of supporting a resident population at 2100, although the timing and extent of climate-mediated habitat decline is highly uncertain.

Unit 5 – Based on evaluation of verified historic records, it is uncertain whether this geographic unit historically supported a small but persistent resident population or supported resident lynx only ephemerally. There are very few verified lynx records in the GYA from 1920-1999, but several resident lynx and evidence of reproduction were verified in the late 1990s and early 2000s (around the time the DPS was listed). In addition, at least 9 radio-marked lynx released in Colorado (see below) dispersed northward into or through this unit from 2003-2010, but no lynx have been detected in the GYA since 2010. Most places surveyed in Yellowstone National Park had hare densities clearly too low to support resident lynx. However, parts of the Wyoming Range south of the park, where many historical and most recent occurrences in this unit have been concentrated, had hare densities among the highest documented in the DPS range. No population estimates are available, but expert opinion suggests that this unit may only support 0-10 lynx, and we find no reliable evidence that it once supported a larger or persistent resident population. Therefore, given the uncertainty whether this unit historically or recently supported a persistent resident population and the lack of evidence that it is currently occupied by resident lynx, we concur with experts that it is very unlikely to support a resident population in the future.

Unit 6 – There are currently many more resident lynx in this unit than likely occurred historically, and many more than were known or suspected at the time the DPS was listed. There were even fewer verified records in this unit during the last century than in the GYA, and no reliable evidence of a resident breeding population. However, from 1999-2006, 218 Canadian and Alaskan lynx were released into the San Juan Mountains of southwestern Colorado. As a result of the subsequent reproduction of some of the released lynx and some of their offspring over several generations, resident lynx currently occupy this unit. When the DPS was listed in 2000, 27 of 41 lynx released in 1999 were still alive. The State of Colorado has concluded that its efforts have established a viable lynx population, and the State's lynx experts suggest this unit may currently support 100-250 resident lynx. Recent snow-tracking and camera surveys in the San Juan Mountains in the southern part of the unit documented evidence of continued lynx residency and reproduction. We concur with the expert panel that resident lynx in this unit are likely to persist at year 2025. However, given this unit's apparent historical inability to support a persistent resident population, its relative isolation from other lynx populations, its naturally fragmented habitat and generally very low hare densities, and its generally lower proportion of females producing kittens and low kitten survival, we believe it is less likely than expert projections to support a resident population at 2050 or at 2100. It is possible that hare densities will increase over the next several decades as large areas of forest regenerate from recent extensive insect and fire impacts. However, we expect any increase in hares to be temporary and accompanied by a longer-term insect- and fire-driven decrease in red squirrel (*Tamiasciurus hudsonicus*) abundance.

DPS Viability

In this SSA, we describe the current and future viability of the DPS in terms of resiliency, redundancy, and representation. Resident lynx populations persisted historically and continue to persist in 4 geographic units (Units 1-4). It is uncertain whether Unit 5 (the GYA) historically

supported a small persistent population or if lynx residency was ephemeral; currently, it appears not to support resident lynx. Available evidence suggests that Unit 6 (Colorado) did not historically support persistent lynx presence; however, a resident population has persisted there for more than a decade since the 1999-2006 releases described above. Considering the available information, we find no reliable evidence that the current distribution and relative abundance of resident lynx in the contiguous United States are substantially reduced from historical conditions. This suggests historical and current resiliency among lynx populations in the DPS.

The current broad distribution of resident lynx in large, geographically discrete areas (redundancy) makes the DPS invulnerable to extirpation caused by a single catastrophic event. Because we lack evidence that formerly persistent lynx populations have been lost from any large areas, it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. In fact, as a result of the current population in Colorado, redundancy in the DPS is likely greater, at least temporarily, now than it was historically.

Similarly, resident lynx remain broadly distributed across the range of habitats that has supported them historically, suggesting maintenance of the breadth and diversity of ecological settings occupied within the DPS range (representation). Additionally, observed high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the lynx's range, including the DPS, suggest the past and recent genetic health of lynx populations in the DPS (representation; but see section 2.1). Because there are no indications of significant loss of or current stressors to the genetic health or adaptive capacity of lynx populations in the DPS, we find that the current level of representation within the DPS does not appear to indicate a decrease from historical conditions.

We expect lynx populations in each geographic unit to become smaller and more patchily-distributed due largely to projected climate-driven losses in habitat quality and quantity and related factors. However, the timing, rate, and extent of habitat decline due to projected climate warming and corresponding effects to lynx populations is highly uncertain. Despite some reduced resiliency, we conclude that resident lynx populations are very likely to persist in all 5 units that currently support them (Units 1-4 and 6) in the near-term (2025) and in all or most of those units at 2050, with corresponding maintenance of redundancy and representation in the DPS over that time span. We and the experts we consulted have low confidence in predicting the likely conditions of DPS populations beyond 2050. That said, smaller, more isolated populations would be less resilient and more vulnerable to demographic and environmental stochasticity and genetic drift and, therefore, at higher risk of extirpation. Although predictions out to 2100 are highly uncertain, it is possible that resident lynx populations could be functionally extirpated from some units by the end of the century. Should extirpations occur, this would indicate a loss of resiliency, reduced redundancy and representation, and an increased risk of extirpation of the DPS.

Chapter 1: Introduction

The Service designated Canada lynx in the contiguous United States as a DPS because of differences in the management of lynx and lynx habitats across the international boundary with Canada and because of the climatic, vegetative, and ecological differences in lynx habitat compared to the northern parts of the species' range in Canada and Alaska (62 FR 28654-28655). The Service listed the DPS as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on some Federal lands to provide for the conservation of lynx habitats and populations (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (i.e., the DPS is recovered or no longer warrants ESA protections; U.S. District Court MT 2014b, p. 2). We completed this SSA (version 1.0) to summarize the best available scientific information on the current status and likely future viability of the DPS. This SSA will inform a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the ESA and (2) a recovery plan is needed to guide conservation and recovery of the lynx DPS.

1.1 Background

The Canada lynx is a North American wild cat that is most strongly associated with northern-latitude boreal forests (taiga) of Canada and Alaska (McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 373-374; Mowat *et al*. 2000, p. 272). It is a prey specialist and relies heavily on its primary prey, the snowshoe hare (*Lepus americanus*), to support survival, reproduction, recruitment, and, therefore, population persistence (Ruggiero *et al*. 2000a, p. 110; Mowat *et al*. 2000, p. 270; Steury and Murray 2004, pp. 128, 136-138; USFWS 2005, p. 2; Interagency Lynx Biology Team [ILBT] 2013, pp. 30-34; 79 FR 54808-54809). Lynx distribution and population persistence are also influenced by snow conditions (e.g., Peers *et al.* 2012, pp. 4-9). It is generally restricted to areas that receive deep and persistent unconsolidated ("fluffy") snow, which is thought to allow lynx, with their proportionately longer limbs and very large feet, to outcompete other terrestrial hare predators that are less efficient in such conditions (McCord and Cardoza 1982, pp. 748-749; Quinn and Parker 1987, p. 684; Buskirk *et al*. 2000a, pp. 89-94; Buskirk *et al*. 2000b, pp. 400-401; Ruggiero *et al*. 2000b, pp. 445–449; Hoving 2001, p. 75; Hoving *et al*. 2005, p. 744-749; Carroll 2007, entire; Gonzalez *et al*. 2007, entire; ILBT 2013, pp. 25-26; 79 FR 54809).

The lynx is generally considered secure, widespread, abundant, and distributed throughout most of its historical ranges in Canada and Alaska, which, combined, account for roughly 98 percent of the species' distribution. Lynx are distributed across approximately 5.5 million km^2 (2.1 million mi^2) in Canada (Environment Canada 2014, p. 2) and 534,454 km^2 (206,354 mi^2) in Alaska (Univ. of Alaska Center for Conservation Science 2016, entire; Reimer 2016, *pers. comm.*). The southern peripheries of the boreal forest and the distributions of snowshoe hares and lynx extend into the northern contiguous United States (Bittner and Rongstad 1982, p. 146;

McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 379-382; Hodges 2000a, pp. 163-173; McKelvey *et al*. 2000a, pp. 242-253), where the 6 geographic units evaluated in this SSA represent the other 2 percent of the species' breeding distribution (approximately 131,168 km^2 [50,644 mi^2]; see fig. 1, above, and table 2, below).

We consider "southern" lynx populations to include all those in the contiguous United States and in the southern parts of the adjacent Canadian provinces of (east to west) Nova Scotia, New Brunswick, Quebec (south of the Saint Lawrence Seaway and River), Ontario (north of the Great Lakes and Minnesota), Manitoba, Saskatchewan, Alberta, and British Columbia (e.g., see Ivan and Shenk 2016, p. 1051, fig. 1). Lynx populations in the DPS and on the margin of the range in adjacent Canadian provinces seem to function as peripheral subpopulations of a larger metapopulation that is broadly distributed across Canada and Alaska (McKelvey *et al*. 2000b, p. 25; 68 FR 40077; also see 2.2 below). The demographic and genetic health and persistence of DPS populations are thought to be influenced by connectivity with, and immigration of lynx from, larger populations in Canada (McKelvey *et al.* 2000b, pp. 21, 33; Schwartz *et al.* 2002, entire; 78 FR 59434, 59447; 79 FR 54815).

Lynx were documented historically in 24 of the Lower 48 States (McKelvey *et al.* 2000a, pp. 207-232), but records in many places are associated with cyclic "irruptions" of large numbers of lynx dispersing from southern Canada during the decline/low phase of snowshoe hare population cycles, roughly every 10 years. Many of these occurrences were in anomalous habitats, and lynx were unable to persist and establish populations in most of these areas (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 242, 253; Aubry 2006, pp. 1-2; ILBT 2013, p. 23; see also section 2.3.2). Habitats capable of supporting persistent resident lynx populations in the contiguous United States occur over a much smaller geographic area that includes parts of the Northeast (primarily northern Maine), western Great Lakes (northeastern Minnesota), Rocky Mountains (northern Idaho, northwestern Montana; perhaps also parts of northeastern Washington, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming, and parts of western Colorado), and the eastern Cascade Mountains of northern Washington (68 FR 40077-40080; USFWS 2005, p. 3; 79 FR 54806-54807; Lynx SSA Team 2016a, pp. 6-7). Although uncertainty remains regarding the historical distribution of resident lynx in the contiguous United States, and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial changes in population status in the contiguous United States has been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016a, p. 11; also see section 2.3.2).

The Service designated lynx in the contiguous United States as a DPS and listed it as threatened under the ESA in 14 states in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on U.S. Forest Service (USFS) and Bureau of Land Management (BLM) lands in those states (65 FR 16052). In 2003, in response to a court memorandum opinion on the 2000 listing rule, the Service reaffirmed its determination of the lynx DPS and its status as threatened under the ESA (68 FR 40076). The Service completed a recovery outline in 2005 (USFWS 2005, entire), designated critical habitat for the DPS in 2006

(71 FR 66008) and, in 2007, again in response to a court order, clarified its determinations of "significant portion of the range" and that all lynx in the contiguous United States constitute a single DPS (72 FR 1186). Also in 2007, the Service announced that it would initiate a 5-year status review of the DPS (72 FR 19549). The Service revised the critical habitat designation for the DPS in 2009 (74 FR 8616) and 2014 (79 FR 54782) and, concurrent with the latter, rescinded the state-based definition of the DPS boundary to formally extend ESA protection to lynx "where found" in the contiguous United States, including New Mexico and other states that were not included in the original DPS range (79 FR 54804). Also in 2014 and as described above, the U.S. District Court for the District of Montana ordered the Service to complete a recovery plan for the lynx DPS by January, 2018, unless it finds that such a plan is not necessary. The Service reinitiated the 5-year status review in 2015 (USFWS 2015a, entire), and that review and potential recovery planning pursuant to it will be informed by this SSA report. On September 7, 2016, the U.S. District Court for the District of Montana remanded the 2014 critical habitat designation to the Service for further consideration (U.S. District Court MT 2016, entire).

The 6 geographic units evaluated in this SSA encompass all areas of the contiguous United States that currently support or are believed to have recently (since the DPS was listed in 2000) supported persistent resident lynx populations (fig. 1, above). Five of the 6 geographic units were designated as "Core Areas" in the Recovery Outline, and western Colorado was designated a "Provisional Core Area" (USFWS 2005, pp. 4-6, 21, 23). With the exception of western Colorado, the SSA units reflect the areas the Service designated as critical habitat in 2014 (79 FR 54782). Some areas adjacent to these geographic units are known or suspected to intermittently support resident lynx and occasional reproduction. Uncertainty remains as to whether resident lynx populations occurred historically in other areas not encompassed by the geographic units evaluated here.

The 6 geographic units include Federal, private, State, and Tribal lands, and proportions vary among the units, with private lands predominating in Maine, a mix of ownerships present in Minnesota, and Federal lands predominating in the western units (table 2).

Table 2. Lynx SSA Unit Sizes and Percent Ownership.

Unit[1]	Unit Size (km^2)	Percent of SSA Area	Land Ownership/Management (Percent)[2]						
			Federal[3]				Private	State	Tribal
			All Federal	USFS	NPS	BLM			
1	28,909	22.0	1.2	0	1.2	0	90.4	7.3	0.9
2	21,101	16.1	47.4	44.9	2.5	0.01	15.5	36.2	1.0
3	26,997	20.6	84.3	69.3	13.6	1.5	8.0	4.1	3.5
4	5,176	3.9	91.5	84.6	6.7	0.1	0.3	8.2	0
5	23,687	18.1	97.6	79.7	16.7	1.1	2.2	0.3	0
6	25,294	19.3	90.1	85.2	1.8	3.1	9.3	0.6	0
All Units	131,164	100	63.8	55.6	7.1	1.1	26.3	8.8	1.1

[1] Unit 1 - Northern Maine; Unit 2 - Northeastern Minnesota, Unit 3 - Northwestern Montana/Northeastern Idaho, Unit 4 - North-central Washington, Unit 5 - the Greater Yellowstone Area (Southwestern Montana/Northwestern Wyoming), Unit 6 - Western Colorado.

[2] Unit sizes and ownership for units 1-5 are those calculated for the areas designated in 2014 as lynx critical habitat, including some Tribal, State and private lands that met the criteria for critical habitat but which were excluded from the designation in accordance with section 4(b)(2) of the Endangered Species Act. Unit 6 size and ownership were calculated by the Service's Western Colorado Field Office in coordination with Colorado Parks and Wildlife based on telemetry data from radio-marked lynx.

[3] USFS = U.S. Forest Service; NPS = National Park Service; BLM = Bureau of Land Management.

1.2 SSA Framework and Report

The Service is engaged in a number of efforts to improve the implementation of the ESA[1]. As part of this effort, our Endangered Species Program has developed the Species Status Assessment (SSA) Framework to guide how we assess the best scientific and commercial data available when evaluating the biological status of species. The purpose of the SSA Framework is to provide a consistent, integrated, conservation-focused, and scientifically robust approach to assessing a species' biological status such that the information and analysis are useful to all decisions and activities under the ESA. The SSA does not result in a decision document; rather, it provides the biological information and scientific analysis in support of ESA decisions.
The SSA Framework entails 3 iterative assessment stages (fig. 3; USFWS 2016a):

[1] See: http://www.fws.gov/endangered/improving_ESA/.

1. **Species' Needs**. An SSA begins with a compilation of the best available biological information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and species levels based on how environmental factors are understood to act on the species and its habitat.

2. **Current Species' Condition**. Next, an SSA describes the current condition of the species' habitat and demographics, and the probable explanations for past and ongoing changes in abundance and distribution within the species' ecological settings (i.e., areas representative of the geographic, genetic, or life history variation across the species' range).

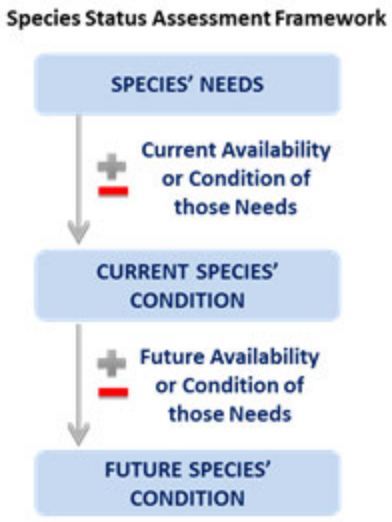


Figure 3. SSA Framework stages.

3. **Future Species' Condition**. Lastly, an SSA forecasts the species' response to probable future scenarios of environmental conditions and conservation efforts. As a result, the SSA characterizes species' ability to sustain populations in the wild over time (viability) based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings.

Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3 Rs") as a lens to evaluate the current and future condition of the species. Resiliency describes the ability of the species to withstand stochastic disturbance events, which is associated with population size, growth rate, and habitat quality. Redundancy describes the ability of a species to withstand catastrophic events, which is related to the number, distribution, and resilience of populations. Representation describes the ability of a species to adapt to changing environmental conditions, which is related to distribution within the species' ecological settings. Together, the 3 Rs, and their core autecological parameters of abundance, distribution and diversity, comprise the key characteristics that contribute to a species' ability to sustain populations in the wild over time. When combined across populations, they measure the health of the species as a whole.

The Species Status Assessment Report (SSA Report) is a summary of the information assembled, reviewed, and assessed by the Service and is based on the best scientific and commercial data available at the time of the assessment. Completed SSA Reports and supporting material can be found at the collaborative repository of the National Park Service and the USFWS called "ServCat"[2].

[2] http://www.fws.gov/Refuges/NaturalResourcePC/IandM/serviceCatalog.html.

1.3 Analytical Approach and Methods

We used the SSA Framework described above to evaluate the current status of resident lynx in the contiguous United States as well as the likelihood that the geographic areas supporting resident lynx in the DPS would continue to do so in the near-term and at mid- and end-of-century (years 2025, 2050, and 2100). We framed our evaluation in terms of the 3 Rs using conceptual modeling (figs. 4-7) based on available published literature, other information on the historical and current status of and threats to lynx in the DPS and, where empirical data are lacking, on formally-elicited expert opinion and best professional judgment (Lynx SSA Team 2016a, entire). The conceptual models below are intended to broadly highlight important relationships thought to influence lynx in the DPS in terms of representation, redundancy, and resiliency. They are not meant to capture every nuance of all possible relationships between lynx and their environments or to illustrate all factors potentially capable of affecting individual lynx or populations.

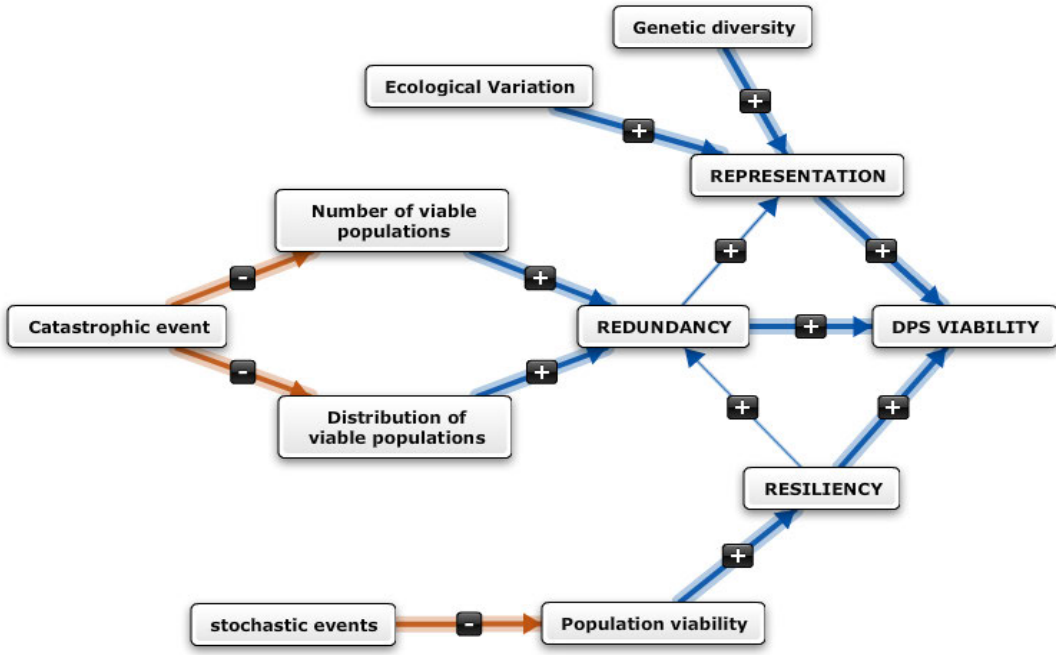


Figure 4. Conceptual model of the factors thought to influence the 3 Rs as they pertain to lynx viability.

We applied the definitions from the SSA Framework for the principles of redundancy, representation, and resiliency, provided in section 1.2, to Canada lynx as described below. We evaluated redundancy and representation at the scale of the DPS as a whole, and resiliency at the scale of lynx populations within each of the 6 geographic units and at the scale of the DPS as a whole.

To evaluate **redundancy** for the lynx DPS, we considered the current and likely future geographic distributions of resident breeding populations and whether the DPS is currently vulnerable to extirpation from a catastrophic event or would be vulnerable in the future. We

consider catastrophic events to be relatively discrete in both time and geographic extent (e.g., wildfires, storms, floods, volcanic eruptions, etc.) and, therefore, we do not consider anthropogenic climate warming as a catastrophic event (see below). Figure 5 shows examples of relationships among factors that may influence redundancy within the lynx DPS.

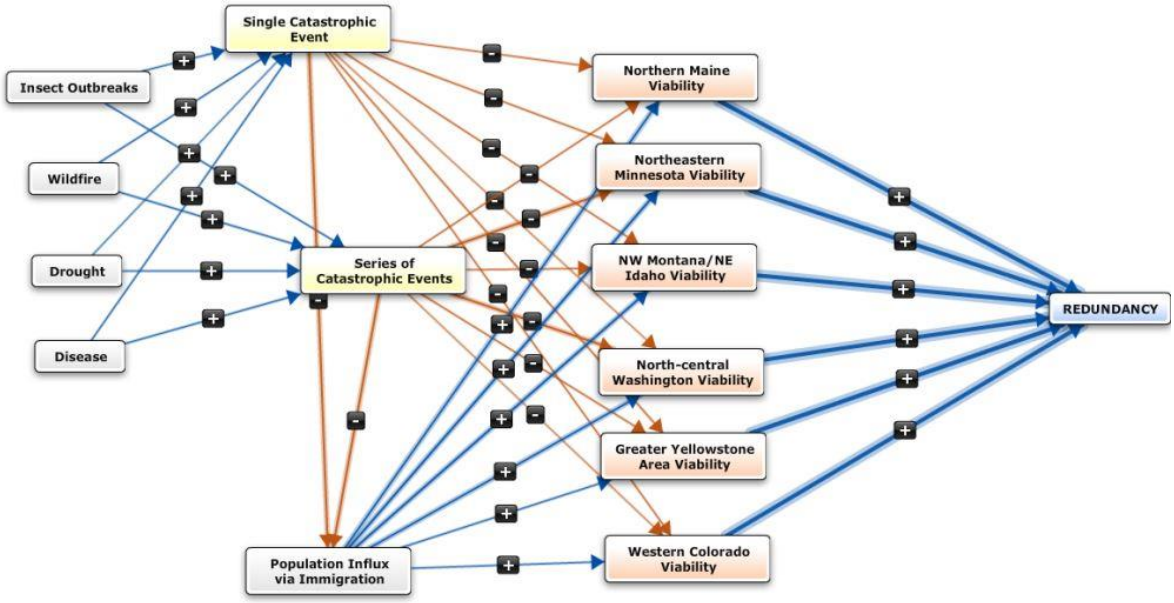


Figure 5. Conceptual model of factors thought to influence redundancy within the lynx DPS.

To evaluate **representation** for the lynx DPS, we considered measures of genetic diversity and heterozygosity, the current and likely future ecological diversity (breadth) of geographic areas occupied by resident breeding populations, and the documented dispersal capabilities of the species, as shown in figure 6 below.

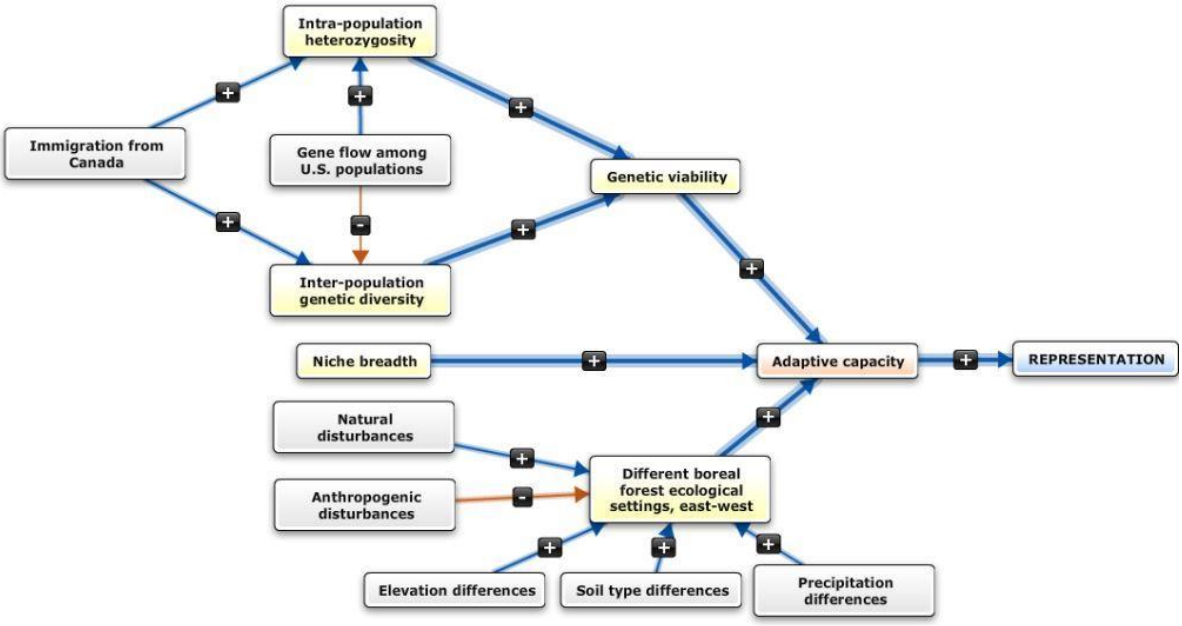


Figure 6. Conceptual model of factors thought to influence representation within the lynx DPS.

Because we lack reliable estimates of the sizes and trends of lynx populations in the DPS and existing demographic data are inadequate to construct empirical models to project population sizes, trends, and viability into the future, our evaluation of the **resiliency** of lynx populations in the DPS was based largely on consideration of recent status updates and formally-elicited expert opinion regarding the likelihood that DPS populations will remain viable into the future. The relationships among factors that influence DPS resiliency are shown in figure 7 below.

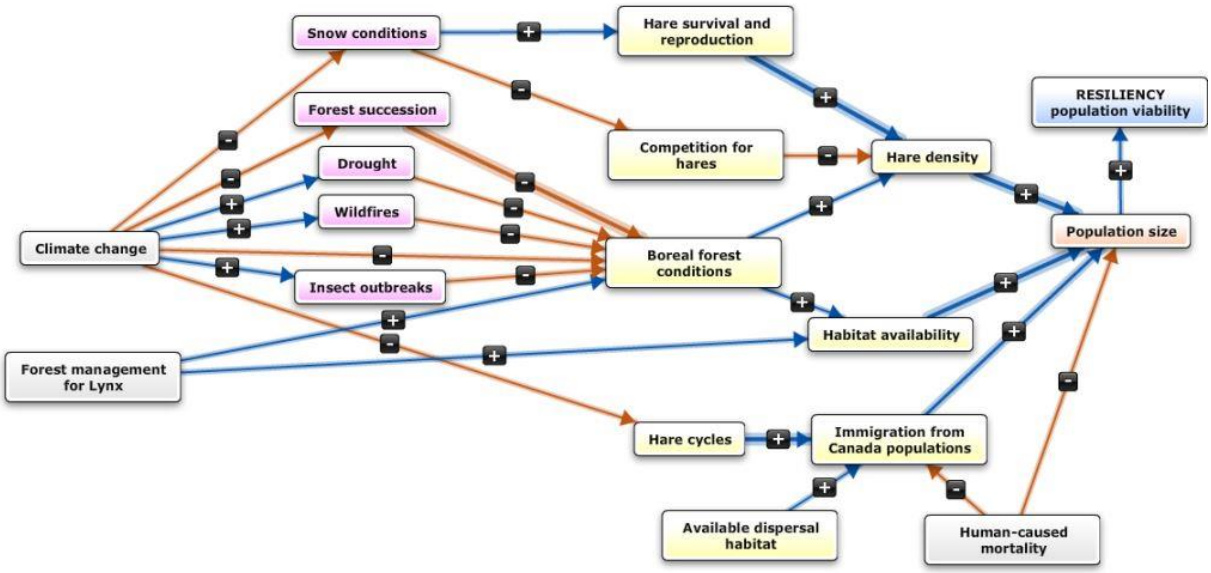


Figure 7. Conceptual model of factors thought to influence the resiliency of lynx populations within the DPS.

We elicited expert input on the current status of resident lynx populations in each geographic unit and the likelihood that each unit would continue to support them in the future (i.e., that resident populations would not be functionally extirpated [reduced to the point that a viable breeding population could no longer be sustained]). To assess both current and future conditions for lynx in the DPS, we considered the adequacy of existing regulatory mechanisms (the factor for which the DPS was originally listed) as well as the anthropogenic influences considered by the Interagency Lynx Biology Team (ILBT) to have the potential to exert population-level (3 Rs) effects on the DPS (climate change, vegetation management, wildland fire management, and habitat loss and fragmentation; ILBT 2013, pp. 68-78).

In Chapter 4, we present our assessment of current conditions based on expert input and our evaluation of the available scientific information regarding lynx populations and habitats and the influencing factors described above for each geographic area. In Chapter 5, we present summaries of experts' predictions regarding the probability of lynx persistence in each geographic unit; the factors they thought would most likely influence those probabilities; and the sources of uncertainty that influenced their confidence in their predictions. We then present our evaluation of the scientific literature regarding how certain anthropogenic factors may influence future conditions for resident lynx in each geographic unit. Other factors were also evaluated for some geographic units if the SSA Core Team member most familiar with that unit felt those factors could pose meaningful, even if less likely, risks to the unit's continued ability to support resident lynx. After considering all of the above, we present our conclusions regarding the future conditions for resident lynx in each geographic unit and we discuss the extent to which our conclusions agree with or differ from the projections provided by the lynx expert panel we consulted, and if they differed, why.

Implicit in our evaluation of the future for lynx in the contiguous United States is our recognition and consideration of a possible future in which the DPS is not listed under the ESA. However, we do not evaluate the unlikely hypothetical future in which all protections and conservation efforts would disappear if the DPS was not listed given (1) the history of lynx management, research, monitoring, and habitat conservation efforts by State wildlife and natural resource agencies in most states throughout the DPS range; (2) similar efforts by Federal land managers and related formal amendments or revisions to most of their land management plans to address the threat for which the DPS was listed (the inadequacy of previous Federal regulatory mechanisms); (3) Tribal lynx conservation efforts and wildlife management philosophies; and (4) the DPS's listing and consultation history. Rather, we assume that although some protections could be relaxed (e.g., less stringent analyses of Federal project-related impacts, potential for some states to reinstitute limited lynx trapping/hunting harvest, reduced incentives for lynx conservation efforts on some private lands), Federal, State, Tribal and some private land managers would continue efforts to conserve lynx and its habitats and to assure persistence of resident lynx populations in those places that can support them in the DPS range. Our evaluation, therefore, considers the possibility of the future relaxing of some lynx conservation measures and efforts should the DPS be delisted, but not the complete absence of all protections for lynx.

Additionally, we do not define and evaluate specific and explicit climate change or greenhouse gas emissions scenarios or attempt to quantify differences in DPS viability or the persistence of resident lynx populations in individual geographic units based on differences in the rate and extent of potential impacts associated with projected continued climate warming. This is because of the limited resolution and inherent uncertainty of available climate models and the inadequacy of existing demographic data for projecting lynx populations in the DPS over time, including their potential responses to a range of climate-mediated potential future habitat conditions. Therefore, this SSA does not constitute or include a formal climate change vulnerability assessment (Glick *et al*., editors, 2011, entire) for the lynx DPS. Instead, underlying our evaluation in this SSA is the recognition that the lynx, as a boreal forest- and snow-associated specialist predator, is probably broadly exposed and highly sensitive to the projected impacts of continued climate warming and has limited capacity to adapt to it (see sections 1.4 and 3.2 below). Therefore, we (along with the experts we consulted and the ILBT) consider lynx populations in the DPS vulnerable (predisposed to be adversely affected; IPCC 2014a, p. 5) to the projected impacts climate change. While we recognize that the pace and extent of impacts would be expected to differ under specific emissions or modeling scenarios, the limitations described above preclude us from quantifying those differences and their potential influence on the likelihood that resident lynx populations will persist in the DPS or in individual geographic units. Finally, in our analyses we do not consider anthropogenic climate warming a catastrophic effect because it is not temporally- and spatially-discrete; characteristics of events traditionally considered catastrophic (e.g., wildfires, floods, storms, volcanic eruptions, etc.). Rather, we consider climate change as an ongoing, pervasive, and cumulative stressor of lynx and their habitats, particularly at the southern margin of the species' distribution, including all geographic areas of the DPS.

1.4 Uncertainties and Assumptions

Several sources of uncertainty had to be accounted for in our analysis, including the paucity of empirical data on lynx population sizes, trends, and other important demographic parameters in the DPS; the influence of immigration of lynx from Canada on the persistence of DPS populations; the effectiveness of habitat management efforts; and the effects of competition on lynx populations. We similarly lack demographic information for snowshoe hares throughout much of the DPS range, and consistent methods to monitor hare and lynx habitats and populations have not been implemented throughout most of the range. And importantly, given the emerging role of climate change as a stressor, uncertainties about the rate and extent of projected future impacts to boreal, subalpine, and montane forests and snow quality, depth, and persistence constrain our ability to precisely predict effects on lynx and hare populations and habitats, including to what degree these changes may affect interactions between lynx and their potential competitors.

To account for these uncertainties in our analysis, we identified a number of critical assumptions based on the scientific literature and input provided by the lynx experts we consulted. We treated the following assumptions as constants in the analysis.

- We assume that, in general, habitat quality and contiguity and hare densities are naturally lower at the southern margin of the lynx's range (in both the contiguous United States and the southern portions of adjacent Canadian provinces) compared to the core of the species' range in Canada and Alaska. Hare populations in the DPS range are noncyclic or weakly cyclic and, although they do not exhibit the dramatic cyclic declines of their northern counterparts, they typically occur at densities on the lower end of those in the northern range. Because of this, lynx densities in most of the DPS range are typically similar to those in the north during hare cycle lows.

- We assume that, as a consequence of generally lower habitat quality and hare densities, only some places within the DPS range are capable of supporting persistent resident lynx populations, while others may naturally support resident lynx only ephemerally, and yet other areas are naturally incapable of supporting resident lynx despite boreal-forest-like vegetation, the presence of some hares, and the occasional or intermittent presence of dispersing or transient lynx.

- We assume that the statuses of lynx populations in individual SSA geographic units are largely independent of those in the other geographic units. This is clearly true for Units 1 and 2, and it is probably true of the western geographic units (3 – 6), despite likely historical north-to-south connectivity and dispersal from or through Unit 3 to Unit 5 and possibly Unit 6, and recent evidence of south-to-north connectivity and dispersal from Unit 6 to and through Units 5 and 3. We are aware of no evidence of east-west connectivity or dispersal between Units 3 and 4.

- We assume that lynx populations in the DPS occur as the southern extensions of larger, cross-border populations or as relatively isolated subpopulations of the larger Canadian populations.

- We assume that lynx exhibit a metapopulation structure in which populations at the southern periphery of the species' range (including all DPS populations and some in southern Canada) receive periodic immigration of lynx dispersing from populations in the core of the Canadian range.

- We assume that connectivity with lynx populations in Canada is important, and that periodic immigration of lynx into the DPS from Canada contributes to the persistence of DPS populations, although the extent to which the demographic and genetic health of DPS populations may depend on immigration remains uncertain.

- We assume that (1) the lynx's morphology confers a competitive advantage in snowy conditions over other terrestrial hare predators, (2) snow conditions (depth, consistency, and persistence) influence the distribution of lynx and its potential terrestrial competitors, and (3) in the absence or loss of these conditions, lynx could be displaced by other terrestrial hare predators.

- We assume that the lynx, as a boreal forest- and snow-associated predator that relies heavily on a single, similarly-specialized prey species, and whose habitats are influenced by climate-mediated disturbance factors (e.g., wildfire, forest insects, wind/ice storms), is highly sensitive and broadly exposed to the impacts of climate warming and has limited adaptive capacity to respond to it. That is, despite some level of behavioral plasticity suggested by differences in snow conditions and specific vegetation communities and stand conditions across the DPS range, we expect that lynx lack the adaptive capacity to shift to non-boreal (e.g., temperate coniferous or deciduous) forests, non-snow-domintated climates, or to persist on alternate prey species where hare densities are or become inadequate. Therefore, we assume lynx populations in the DPS are vulnerable (sensitive, exposed, and with little capacity to adapt; therefore, predisposed to be adversely affected; IPCC 2014a, p. 5) to the projected impacts of continued climate warming.

- We assume that lynx conservation measures and habitat management guidance adopted by the USFS and the BLM via formally amended or revised management plans or conservation agreements with the Service have had a positive influence on DPS lynx populations that occur on Federal lands and will continue to provide benefits as long as those measures and guidance are implemented.

- We assume that the DPS could be delisted in the future and that some of the current protections afforded by the ESA could be lost and/or relaxed. However, we assume that Federal, State, and Tribal agencies and some private landowners would continue to manage for the conservation of resident lynx populations in those places that can support them in the DPS range.

For purposes of the SSA, we forecast potential future conditions for lynx in the DPS through the end of this century, and we asked a panel of 10 lynx experts to provide their opinions on the likelihoods that each geographic unit would support resident lynx populations over the short-term (year 2025), mid-term (2050) and longer-term (2100). As expected, the level of uncertainty regarding the viability of the DPS and each of the factors that may influence it increases the farther into the future we (and the lynx experts we consulted) try to look, and this uncertainty greatly reduces confidence in future projections, particularly beyond mid-century. Beyond that time frame, uncertainty regarding the potential impacts of climate change and other potential stressors to lynx populations in the DPS becomes so great that it precludes meaningful analysis or reliable predictions regarding viability.

Finally, although formal elicitation of expert opinion where empirical information is unavailable or inadequate is an appropriate and scientifically supported approach, we remind readers that the output remains the experts' best professional judgment, which is subjective and, therefore, inherently different than experimentally collected data subjected to rigorous statistical analyses. For purposes of useful and meaningful presentation and comparison among geographic units, it was necessary to combine, quantify, graph, and summarize the qualitative information provided by experts. However, we caution that the results we present, graph, and describe in chapter 5 should not be interpreted as precise, statistically robust estimates of the probability that resident lynx will persist in the DPS or in any individual geographic unit in the future, and readers should consider the inherent limitations and substantial uncertainties in expert responses, particularly over longer time periods.

Chapter 2: Lynx Ecology

In this chapter, we describe the physical characteristics, taxonomy, and genetics of the Canada lynx, its life history and population dynamics, and its taxon-wide and DPS distributions. We rely heavily on recent summaries of this information provided in the revised *Canada Lynx Conservation Assessment and Strategy* (LCAS; ILBT 2013, entire), the Service's recent proposed (2013) and final (2014) rules to revise the designation of critical habitat for the DPS (78 FR 59430-59474; 79 FR 54782-54846), and the results of the October 2015 Canada Lynx Expert Elicitation Workshop (Lynx SSA Team 2016a, entire). We also provide a summary of the pertinent ecological requirements of lynx at the individual, population, and DPS levels. These ecological requirements form the basis of our analyses conducted in Chapters 3 through 5.

2.1 Species Taxonomy, Description, and Genetics

The Canada lynx (order Carnivora; family Felidae) is 1 of 4 species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). There are 3 recognized subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. mollipilosus* ("Arctic lynx," Stone 1900), and *L. c. subsolanus* ("Newfoundland lynx," Bangs

1897; Integrated Taxonomic Information System online database[3], retrieved April 14, 2016). The Canada lynx is believed to have evolved from the Eurasian lynx in the last 200,000 years in North America as a snowshoe hare specialist (Werdelin 1981, p. 69).

The Canada lynx is a medium-sized cat with long legs and large, well-furred paws. In winter, the lynx's fur is dense and has a grizzled appearance with a grayish-brown mix of buff or pale brown fur on the back, and a grayish-white or buff-white fur on the belly, legs, and feet. In summer, its fur is more reddish to gray-brown (McCord and Cardoza 1982, p. 730). It has long tufts of black hairs extending from the tips of its ears, a short, completely black-tipped tail, and often a distinct dish-like facial ruff of pale hairs tipped black. Lynx generally measure 75 to 90 cm (30 to 35 in) long and weigh 6 to 14 kg (14 to 31 lb; Quinn and Parker 1987, table 1; Moen *et al.* 2010a, fig. 2; MDIFW 2012, *unpubl. data*), and males are 13-25 percent larger than females (Mowat *et al.* 2000, p. 267). The lynx's large feet and long legs make it well-adapted for traversing and hunting in deep, powdery snow, where its low foot-loading (weight per surface area of foot) is thought to provide a competitive advantage (Buskirk *et al.* 2000a, p. 90; 2000b, p. 400; ILBT 2013, pp. 26, 36, 81) over other terrestrial predators of snowshoe hares, the lynx's primary prey. In southern Canada and the northern contiguous United States, where the southern edge of the lynx range overlaps the northern edge of the bobcat range, the 2 species are easily confused because of their similar size and appearance. However, the lynx's longer ear-tufts, larger feet, and black-tipped tail distinguish it from the bobcat, which has shorter ear tufts, small feet, and white on the underside of the tail. Bobcats are much more common, widespread, and abundant than lynx in most of the contiguous United States.

Overall, genetics research suggests high gene flow across most of the continental range of lynx, likely because of high dispersal rates, large dispersal distances, and the absence of significant barriers to genetic interchange throughout much of the lynx range, including the DPS (Schwartz *in* Lynx SSA Team 2016a, pp. 11-12). Genetic evidence also indicates interactions between lynx populations even where physical barriers appear most likely to restrict gene flow. For example, although *L. c. subsolanus* on Newfoundland Island is genetically (Row *et al.* 2012, pp. 1262-1266; Koen *et al.* 2015, p. 528) and morphologically (Khidas *et al.* 2013, pp. 597-601) distinct from mainland lynx (*L. c. canadensis*), there is evidence of genetic exchange between the 2 areas, indicating that some lynx are able to cross the 15-60 km- (9-37 mi-) wide Strait of Belle Isle that separates them (Koen *et al.* 2015, p. 527). Similarly, despite some differences in functional genetic markers (unique alleles) in lynx south versus north of the St. Lawrence Seaway/River in eastern Canada, which suggest the potential for evolutionarily significant differences in those areas (Bowman *in* Lynx SSA Team 2016a, p. 14), recent analyses reveal genetic exchange among lynx on either side, indicating that some lynx successfully navigate this barrier (Koen *et al.* 2015, pp. 524-528; Bowman *in* Lynx SSA Team 2016a, p. 12-13). However, Prentice *et al*. (2017, entire) documented natural selection for unique alleles in relatively isolated island populations of lynx in eastern Canada.

Schwartz *et al.* (2003, entire) documented reduced genetic variation (lower mean number of alleles per population and lower expected heterozygosity) among peripheral lynx populations

[3] http://www.itis.gov.

compared to populations in the core of the lynx geographical range in Canada and Alaska. While recognizing that small changes in genetic variation can lead to large changes in population fitness, the authors noted that the differences between core and peripheral populations in their study were small enough to suggest a lack of significant population subdivision (i.e., no indication of genetic isolation, substantial genetic drift, or potential genetic ''bottlenecks'' among DPS populations; Schwartz *et al.* 2003, p. 1814; 79 FR 54793). This finding is consistent with their earlier work, which documented high levels of gene flow (the highest yet documented for any carnivore) between core and peripheral lynx populations despite large separation distances (Schwartz *et al.* 2002, entire). Their results did not suggest that reduced genetic variation among peripheral populations was because of human disturbance (i.e., habitat loss/fragmentation on the southern periphery of the geographic range; Schwartz *et al.* 2003, p. 1814), but the authors concluded that the persistence of lynx populations in the contiguous United States depends on dispersal from larger (core) populations (Schwartz *et al.* 2002, p. 522).

Within the contiguous United States, minor genetic sub-structuring has been documented among lynx subpopulations in western Montana (Schwartz *in* Lynx SSA Team 2016a, p. 12 and Appendix 5). Genetic diversity may be somewhat greater among lynx in western Colorado than elsewhere in the DPS range because of the broad geographic distribution of the source populations that contributed to the lynx releases in Colorado (45 lynx from Quebec, 4 from Manitoba, 91 from British Columbia, 48 from The Yukon Territory, and 30 from Alaska). Additionally, lynx-bobcat hybridization has been documented in Minnesota, Maine, and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where male bobcats bred with female lynx to produce fertile offspring with lynx-like ear tufts, intermediate foot-size, and bobcat-like fur (ILBT 2013, p. 35). In Minnesota from 2000 to 2015, DNA analyses documented 13 distinct hybrid individuals (Moen and Catton *in* Lynx SSA Team 2016a, pp. 13, 19); hybrids have yet to be documented in the western portion of the lynx's range (Schwartz *in* Lynx SSA Team 2016a, p. 12). At a continental scale, Koen *et al*. (2014b, pp. 111-113) found a low level of bobcat-lynx genetic introgression (i.e., hybridization) but suggested it could increase if bobcat distribution shifts northward in the future as a result of continued climate warming (also see section 3.2 below).

Currently, there is no indication that the levels of connectivity and gene flow between lynx populations in the DPS and those in the core of the lynx's range are inadequate to maintain the genetic health of DPS populations. Given the connectivity of most DPS units with lynx populations and habitats in Canada (particularly Units 1-4, which have the strongest evidence of historically persistent resident lynx populations), the noted dispersal capabilities of lynx, evidence of dispersal in both directions across the Canada-United States border (Aubry *et al.* 2000, pp. 386-387; Squires *et al.* 2006a, p. 38; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and the small number of immigrants thought necessary to maintain genetic variability in peripheral populations (McKelvey *et al.* 2000b, pp. 23-24), genetic isolation, biologically meaningful genetic drift, or potential genetic ''bottlenecks'' appear unlikely among most DPS populations in the near future (79 FR 54793). However, the potential for genetic drift would be expected to increase at some point in the future if lynx and hare habitats shift

northward and upslope, as projected with continued climate warming, resulting in reduced connectivity and gene flow among smaller and more isolated lynx populations at the periphery of the range (Schwartz 2017, pp. 4-5; also see section 3.2).

2.2 Life History and Population Dynamics

All aspects of lynx life history are inextricably tied to its primary prey, the snowshoe hare (fig. 8), which comprises most of the lynx diet throughout its range (Nellis *et al.* 1972, pp. 323–325; Brand *et al.* 1976, pp. 422–425; Koehler and Aubry 1994, pp. 75, 85; Apps 2000, pp. 358–359, 363; Aubry *et al.* 2000, pp. 375–378; Mowat *et al.* 2000, pp. 267–268), including the DPS (Koehler 1990a, p. 848; von Kienast 2003, pp. 37–38; Squires *et al.* 2004a, p. 15, table 8; Moen 2009, p. 7; Vashon *et al.* 2012, p. 11; Olson 2015, pp. 60-69; Ivan and Shenk 2016, p. 1053). Lynx are highly specialized hare predators and require landscapes that consistently support relatively high hare densities (McCord and Cardoza 1982, p. 744; Quinn and Parker 1987, pp. 684-685; Aubry *et al.* 2000, pp. 375-378).

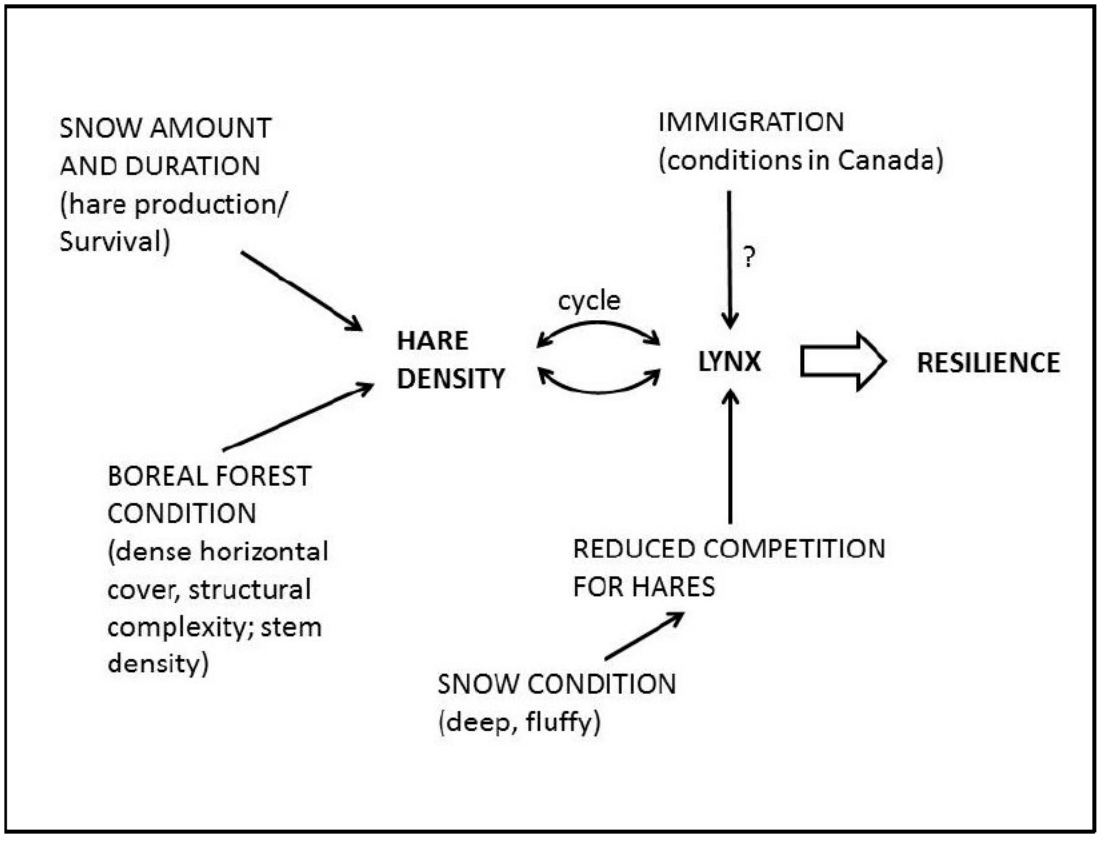


Figure 8. Generalized relationship between habitat conditions and hare and lynx population dynamics and their influence on lynx population resiliency.

Although lynx take a variety of alternate prey species, especially red squirrels (*Tamiasciurus hudsonicus*), which may be important when hare numbers are low (O'Donoghue *et al.* 1997, pp. 154-155; 1998, pp. 1198-1205; Ivan and Shenk 2016, pp. 1054-1056), hare abundance is the major driver of lynx population dynamics. Lynx denning area selection, pregnancy rates and

litter sizes, as well as survival (kitten, subadult, and adult), recruitment, and dispersal rates, and population age structure, home range sizes, density, and distribution are all strongly influenced by hare abundance (Koehler and Aubry 1994, pp. 75-76, 80-83; Apps 2000, entire; Aubry *et al.* 2000, pp. 375-390; Mowat *et al.* 2000, pp. 270-294; Moen *et al.* 2008a, p. 1507; Organ et al. 2008, p. 1516; Vashon *et al.* 2012, p. 16; ILBT 2013, pp. 18, 22-24, 26-34).

Lynx and snowshoe hares are strongly associated with moist boreal forests, where winters are long, cold, and snowy (Bittner and Rongstad 1982, p. 154; McCord and Cardoza 1982, p. 743; Quinn and Parker 1987, p. 684-685; Agee 2000, p. 39-47; Aubry *et al.* 2000, pp. 373-382; Hodges 2000a, pp. 183-191; 2000b, pp. 136-140; McKelvey *et al.* 2000a, pp. 211-232). The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (*Picea* spp.) and fir (*Abies* spp; Elliot-Fisk 1988, pp. 34-35, 37-42). Snowshoe hares feed on conifers, deciduous trees, and shrubs (Hodges 2000a, pp. 181-183) and are most abundant in forests with dense understories that provide forage, cover to escape from predators, and protection during extreme weather (Wolfe *et al.* 1982, pp. 665-669; Litvaitis *et al.* 1985, pp. 869-872; Hodges 2000a, pp. 183-195; 2000b, pp. 136-140). Lynx population dynamics, survival, and reproduction are closely tied to snowshoe hare availability, making snowshoe hare habitat the primary component of lynx habitat. However, lynx do not occur everywhere within the range of snowshoe hares in the contiguous United States (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729). This may be due to inadequate abundance, density, or spatial distribution of hares in some places, or the absence of snow conditions that would provide lynx a competitive advantage over other terrestrial hare predators (see below), or a combination of these factors (79 FR 54809).

The boreal forest landscapes lynx and hares occupy are naturally dynamic. Forest stands within the landscape may experience abrupt changes after natural or human-caused disturbances such as fire, insect outbreaks, wind, ice, disease, and forest management (e.g., timber harvest or thinning) and more gradual changes as they undergo succession and regenerate after such events (Elliot-Fisk 1988, pp. 47-48; Agee 2000, pp. 47-69). As a result, lynx habitat is a shifting mosaic of forest patches of variable ages and changing quality (68 FR 40077). These stands of differing ages and conditions provide lynx foraging or denning habitat (or may provide these in the future depending on patterns of disturbance and forest succession), and some serve as travel routes for lynx moving between foraging and denning habitats (McKelvey *et al.* 2000c, pp. 427-434; Hoving *et al.* 2004, pp. 290-292).

Over much of the lynx's range, hare densities are higher in regenerating, earlier successional forest stages because they often have greater understory structure (dense horizontal cover) than mature forests (Buehler and Keith 1982, p. 24; Wolfe *et al.* 1982, pp. 665-669; Koehler 1990a, pp. 847-848; Hodges 2000a, pp. 183-195; Homyack 2003, pp. 63, 141; Griffin 2004, pp. 84-88). However, snowshoe hares also can be abundant in mature forests with dense horizontal cover, particularly in the Northern Rocky Mountains (Griffin 2004, pp. 53-54; Griffin and Mills 2009, pp. 1492-1496; Hodges *et al.* 2009, p. 876; Squires *et al.* 2010, pp. 1653-1657; Berg *et al.* 2012, pp. 1483-1487). These mature forests may be a source of hares for other adjacent forest types (Griffin and Mills 2009, pp. 1492, 1495-1496), and they may provide especially important

winter foraging habitats (Squires *et al.* 2010, pp. 1655-1657), which may be the most limiting habitat for lynx (Squires *et al.* 2010, pp. 1655-1657; ILBT 2013, pp. 17, 27). They also are more temporally-stable (i.e., they provide high-quality hare habitat for a longer period of time) than regenerating stands, which may foster high hare densities for a variable window of time between stand-initiation and stem-exclusion stages of succession, after which older regenerating stands may persist, in the absence of disturbance, for many years as lower-quality hare habitat (ILBT 2013, pp. 62, 71, 127).

Lynx generally concentrate hunting activities in areas where snowshoe hare densities are high (Koehler *et al.* 1979, p. 442; Ward and Krebs 1985, pp. 2821-2823; Murray *et al.* 1994, p. 1450; O'Donoghue *et al.* 1997, pp. 155, 159-160 and 1998, pp. 178-181), but several studies showed that lynx focused foraging efforts in stands with intermediate hare densities and forest structural complexity that occurred at the edges of the highest density habitat, suggesting that lynx must balance between hare abundance and accessibility (Fuller and Harrison 2010, pp. 1276–1277; Simons-Legaard *et al.* 2013, p. 574). Because understory density within a forest stand changes over time, hare habitat quality and corresponding hare densities also shift over time across boreal forest landscapes.

Hare populations in the core of the lynx range in Canada and Alaska undergo well-documented dramatic 8 to 11 year cycles during which hare numbers may fluctuate 10 to 25 fold or more, with peak densities as high as 23 hares/hectare (ha; 9.3 hares/acre [ac]) and lows of 0.1 hares/ha (0.04 hares/ac; Hodges 2000b, pp. 117-121; Vashon 2015, p. 4). Hare densities are generally lower at the southern periphery of lynx distribution, and hare population cycles are generally much less pronounced or absent entirely among some hare populations in southern Canada and in the contiguous United States (Hodges 2000a, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016a, pp. 16-17). In the contiguous United States, average stand-level hare densities may exceed 2 hares/ha (0.8 hares/ac; Walker 2005, pp. 20, 85; McCann 2006, p. 15; Robinson 2006, pp. 26-36, 62-75; Homyack *et al.* 2007, pp. 10-11; Griffin and Mills 2009, p. 1492; Vashon *et al.* 2012, p. 14), but in many parts of the DPS, landscape-level densities are lower, ranging from just above to well below the 0.5 hares/ha (0.2 hares/ac) density thought necessary to sustain lynx home ranges and populations (Hodges 2000a, pp. 168-169, 185; Ruggiero *et al.* 2000b, pp. 446–447; Squires and Ruggiero 2007, pp. 313-314; Maletzke *et al.* 2008, pp. 1476-1477; Zahratka and Shenk 2008, pp. 910-911; Hodges *et al.* 2009, pp. 873-877; Ivan 2011a, pp. 91-92, 95-102; Berg *et al.* 2012, p. 1483; ILBT 2013, pp. 24, 26, 90; Ivan *et al.* 2014, entire).

Lynx prey opportunistically on other small mammals and birds, especially red squirrels, grouse (*Bonasa umbellus, Dendragapus* spp., *Falcipennis canadensis*) and ptarmigan (*Lagopus* spp.), but alternate prey species do not sufficiently compensate for low availability of snowshoe hares, and lynx populations likely cannot persist over time in areas with consistently low hare densities (Brand *et al.* 1976, pp. 422–427; Brand and Keith 1979, pp. 833–834; Koehler 1990a, pp. 848–849; Mowat *et al.* 2000, pp. 267–268). Hares constitute the majority of the biomass in lynx diets even in areas with relatively low or marginal hare densities (Koehler and Aubry 1994, p. 85; Apps 2000, pp. 362-363; Aubry *et al.* 2000, pp. 375-378; Roth *et al.* 2007, pp. 2740-2741;

Squires and Ruggiero 2007, pp. 310-313; Hanson and Moen 2008, p. 9; Maletzke *et al.* 2008, pp. 1475-1477; Shenk 2009, pp. 13, 16). This remains true in years when hare abundance is low and proportionally more alternate prey items are taken (Brand *et al*. 1976, pp. 424-427; O'Donoghue *et al*. 1998, pp. 1198-1200; Ivan and Shenk 2016, p. 1053). Nonetheless, alternate prey, particularly red squirrels, may contribute to lynx persistence through cyclic hare population lows in the core of the range (O'Donoghue *et al*. 1997, pp. 156-160; 1998, pp.1204-1205) and may be important at the southern periphery of lynx range where hare numbers may be chronically marginal or low and where red squirrels may be less vulnerable than hares to projected impacts of continued climate warming (Roth *et al*. 2007, pp. 2740-2741*;* Peers *et* al. 2014, entire; Ivan and Shenk 2016, pp. 1050, 1054-1056).

Lynx typically mate in March and April, and kittens are born from late April to mid-June after a 60- to 70-day gestation period (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Female lynx typically reach reproductive maturity in their second year (at 22 months of age); however, when hares are abundant, females may breed at 10 months of age and produce kittens as 1-year-olds (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Males do not seem to breed as yearlings, and they do not contribute to rearing of young (ILBT 2013, p. 30). Lynx dens are typically located in areas of dense cover, where coarse woody debris, such as downed logs and windfalls, provides security and thermal cover for lynx kittens (McCord and Cardoza 1982, pp. 743-744; Koehler 1990a, pp. 847-849; Slough 1999, p. 607; Squires and Laurion 2000, pp. 346-347; Organ *et al.* 2008, entire; Squires *et al.* 2008, pp. 1497, 1501-1505; Moen and Burdett 2009, pp. 5-8). Dens have been documented in both mature and younger boreal forest stands (Mowat *et al.* 2000, pp. 274-275; Squires *et al.* 2008, p. 1497; ILBT 2013, pp. 29-30; 78 FR 59441-59442; 79 FR 54809-54810; Organ *et al.* 2008, entire), and the amount of structure (e.g., downed trees; large, woody debris; tip-up mounds) seems to be more important than the age of the forest stand for lynx denning habitat (Mowat *et al.* 2000, pp. 274-275, Organ *et al.* 2008, p. 1516; Moen and Burdett 2009, p. 5). Denning habitat is not thought to be a limiting factor for lynx in the DPS (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517; Squires *et al.* 2008, p. 1505; ILBT 2013, p. 30; 79 FR 54790). Dens must be near foraging habitat to allow females to adequately provision dependent kittens, and females seem to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). Females attend kittens at the natal den site and 1 or more (up to 5) alternate or maternal dens until kittens are about 6-10 weeks old (Squires *et al.* 2008, p. 1502; Olson *et al.* 2011, pp. 458-460; Vashon *et al.* 2012, p. 17; ILBT 2013, p. 29).

Thereafter, kittens remain with their mothers through their first winter, apparently learning from her how to hunt and capture prey, initially on a small portion of her home range, but by fall on the larger area the female used before kittens were born (Mowat *et al.* 2000, pp. 269, 278). Juveniles remain closely associated with their mothers until February or March, when family groups begin to break up, with young typically dispersing in April and May (Mowat *et al.* 2000, pp. 278-279) to establish their own home ranges. Female offspring may establish home ranges overlapping or adjacent to their mother's home range and maintain mother-daughter bonds throughout their lives (Mowat *et al.* 2000, pp. 279-280). Male home ranges may slightly overlap

adjacent male home ranges. While male home ranges typically overlap 1 to 3 female home ranges, and female home ranges are partially or completely encompassed by a male's home range, core areas within home ranges appear to be exclusive except during the breeding season (Koehler and Aubry 1994, pp. 90-91; Mowat *et al.* 2000, pp. 276-280; Vashon *et al.* 2012, pp. 17, 22-23). Fidelity to home ranges over several years has been documented for both sexes, but shifts and abandonment of home ranges have also been documented (Koehler and Aubry 1994, p. 91; Mowat *et al.* 2000, p. 277). Lynx have been documented to live up to 16 years in the wild (Kolbe and Squires 2006, entire).

Lynx populations in Canada fluctuate in response to the cycling of hare populations (Elton and Nicholson 1942, pp. 241–243; Hodges 2000b, pp. 118–123; Mowat *et al.* 2000, pp. 265–272), with synchronous fluctuations in lynx numbers emanating from the core of the Canadian population and spreading over vast areas, generally lagging hare numbers by 1 year (McKelvey *et al.* 2000a, pp. 232, 239; Mowat *et al.* 2000, pp. 266, 270). When hares are abundant, lynx have higher pregnancy rates and larger litter sizes, higher kitten survival, and lower adult mortality, resulting in rapid population growth during the increase phase of the hare cycle (Slough and Mowat 1996, pp. 955–956; Mowat *et al.* 2000, pp. 266, 270–272, 281–289). When hare populations are low, female lynx produce few or no kittens that survive to independence (Nellis *et al.* 1972, pp. 326–328; Brand *et al.* 1976, pp. 420, 427; Brand and Keith 1979, pp. 837–838, 847; Poole 1994, pp. 612–616; Slough and Mowat 1996, pp. 953–958; O'Donoghue *et al.* 1997, pp. 158–159; Aubry *et al.* 2000, pp. 388–389; Mowat *et al.* 2000, pp. 285–287). When hares decline, lynx mortality rates increase, largely because of starvation, and home range sizes and dispersal/emigration rates also increase (Ward and Krebs 1985, pp. 2821–2823; O'Donoghue *et al.* 1997, pp. 156, 159; Poole 1997, pp. 499–503; Mowat *et al.* 2000, pp. 265–272, 278, 281–294). Lynx numbers decline dramatically during the ''crash'' phase of the hare cycle (Slough and Mowat 1996, p. 956; Mowat *et al.* 2000, pp. 283-285), when many lynx starve and many others abandon home ranges and disperse in search of food, with many dispersers also dying, often soon after initiating dispersal (Mowat *et al.* 2000, p. 293).

In Canada, lynx abundance may be 3 to 17 times higher at the peak versus the low of the hare cycle, with lynx densities reaching 30-45/100 km^2 (78-117/100 mi^2) in optimal dense regenerating forests 15-40 years post-fire, 8-20/100 km^2 (21-52/100 mi^2) in older forests or further south, and < 3/100 km^2 (< 8/100 mi^2) at the hare cycle low (Slough and Mowat 1996, pp. 952, 955; Mowat *et al.* 2000, p. 283; Hatler and Beal 2003, pp. 2, 5; Environment Canada 2014, p. 1). In southern Canada, where hares are less abundant and hare population cycles are muted or absent, lynx populations may be stable at 2-3/100 km^2 (5-8/100 mi^2; Environment Canada 2014, p. 1). Lynx densities estimated in the contiguous United States have ranged from 9.2-13/100 km^2 (24-34/100 mi^2), including kittens, in Maine's highest-quality habitat when hares were abundant (Vashon *et al.* 2008a, pp. 1483-1484; Vashon *et al.* 2012, pp. 14-15) to 2.3/100 km^2 (6/100 mi^2) in Washington when hare abundance was low (Koehler 1990a, pp. 847-850).

Correspondingly, hare abundance may also influence lynx home range size. Ward and Krebs (1985, pp. 2819-2820) documented a 3-fold increase in home range size in southwestern Yukon, from 13 km^2 (5 mi^2) on average when hares were abundant and increasing to 39 km^2 (15

mi^2) when hare density was low (90 percent MCP method). Poole (1994, pp. 613-614) documented a similar trend in the Northwest Territories, where lynx home range size increased from 17 km^2 (7 mi^2; males and females combined) when hares were abundant, to 44 km^2 (17 mi^2) and 62 km^2 (24 mi^2) for males and females, respectively, when hare numbers declined (95 percent MCP method). In contrast, Breitenmoser *et al.* (1993, p. 552) reported no change in lynx home range size despite a 10-15 fold increase in lynx density as hare abundance increased in the southern Yukon (home range estimation method not provided). Similarly, in Maine, lynx home range size did not increase when hare densities in the best habitats declined by half from 2 hares/ha (0.8 hares/ac) to 1 hare/ha (0.4 hares/ac; Mallett 2014, pp. 53-93; 90 percent fixed kernel method). In general, hare and lynx densities are lower and lynx home ranges larger at the southern periphery of the lynx's range, including most of the DPS range, and lynx densities are similar to those of northern populations during the low phase of the hare population cycle (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367; Burdett *et al*. 2007, pp. 463-465).

Although empirical data are lacking and would be difficult to acquire (ILBT 2013, p. 82), the lynx's physical adaptations (described above) are thought to provide lynx a seasonal advantage over potential terrestrial competitors and predators, which generally have higher foot-loading, causing them to sink into the snow more than lynx (McCord and Cardoza 1982, p. 748; Murray and Boutin 1991, entire; Buskirk *et al.* 2000a, pp. 86-95; Ruediger *et al.* 2000, pp. 1-11; Ruggiero *et al.* 2000b, pp. 445, 450). Buskirk *et al.* (2000a, entire) described potential exploitation (for food) and interference (avoidance) competition between lynx and several other terrestrial and avian predators of hares, several of which have also been documented to prey on lynx. Documented lynx predators include cougar (*Puma concolor*; also mountain lion), coyote (*Canis latrans*), wolverine (*Gulo gulo*), gray wolf (*Canis lupus*), fisher (*Pekania pennant*), and other lynx (ILBT 2013, pp. 33, 35). Bobcats are also likely capable of killing lynx in some circumstances. Although lynx have co-evolved with other predators, the influence of predation on lynx populations is unknown (ILBT 2013, pp. 35-36). Coyotes are now more widespread and abundant in the southern periphery of the lynx distribution than they were historically (Gompper 2002, entire), while cougars have been extirpated from the eastern half of the United States (except Florida; USFWS 2011a, entire) but are more abundant and widespread in the western United States now than in the mid-1900s (Buskirk *et al.* 2000a, p. 89).

The species above, along with red fox (*Vulpes vulpes*), American marten (*Martes americana*), mink (*Mustela vison*), as well as a suite of avian predators (e.g., northern goshawk [*Accipiter gentilis*], northern hawk-owl [*Surnia ulula*], great gray owl [*Strix nebulosi*], and great-horned owl [*Bubo virginianus*]) may compete with lynx for hares (Buskirk *et al.* 2000a, pp. 86-95; ILBT 2013, p. 16). Of these, coyotes are the most likely to exert local or regionally important exploitation competition impacts to lynx, and coyotes, bobcats, and cougars are capable of imparting interference competition effects on lynx (Buskirk *et al.* 2000a, p. 89). Interference would be most likely during summer but also during winter in areas lacking deep, unconsolidated snow (ILBT 2013, p. 36). Except for fisher and marten, lynx predators and potential terrestrial competitors all have higher foot-loading, making them less efficient at traveling and hunting in the snow conditions favorable for lynx (Murray and Boutin 1991, entire; Buskirk *et al.* 2000a, pp 86-95;

Krohn *et al.* 2005, entire) and, therefore, likely limiting, at least seasonally, interactions between lynx and these species. The fisher has foot-loading similar to lynx, and the marten's is even lower (Buskirk *et al.* 2000a, p. 90), but both species have much shorter legs, which likely limits their mobility in deep, unconsolidated snow compared to lynx. The extent to which predation and competition may influence lynx populations in the DPS remains uncertain.

Lynx populations in the contiguous United States seem to function as subpopulations or southern extensions of larger populations in southern and eastern Canada (McKelvey *et al.* 2000b, pp. 21, 25, 33; 65 FR 16052–16082; 68 FR 40077–40099; 71 FR 66025–66035; 74 FR 8616–8641; Koen *et al.* 2015, pp. 527-528). Populations in the DPS are relatively isolated from one another, though most are directly connected via dispersal to lynx populations in Canada (McKelvey *et al.* 2000b, pp. 25-34; U.S Fish and Wildlife Service 2005, p. 2). DPS populations are at the periphery of the species' range and some, particularly in the West (geographic units 3-6), may behave as islands in a mainland-island metapopulation construct. In such a system, larger islands with higher habitat quality and in closer proximity to the mainland would be more likely to support persistent resident populations and to sometimes act as "sources" that produce surplus animals that may disperse to other islands. Smaller islands with lower habitat quality or at greater distance from the mainland may, in contrast, act as "sinks" that depend on immigration from source populations (McKelvey *et al.* 2000b, p. 30), and which may support resident lynx only occasionally, intermittently, or temporarily.

Although lynx habitats are more contiguous in units 1 and 2 than in the western units, and units 1 and 2 are connected to larger contiguous habitats and lynx populations in Canada, they remain peripheral populations, and a metapopulation structure in which they receive intermittent immigration from the larger population may still exist, even if the mainland-island contruct does not apply. Lynx disperse in both directions across the Canada–United States border (Aubry *et al.* 2000, pp. 386-387; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and this connectivity and interchange with lynx populations in Canada is thought to be important to the conservation of lynx populations in the DPS. (McKelvey *et al.* 2000b, p. 33; Schwartz *et al.* 2002, p. 522; U.S Fish and Wildlife Service 2005, p. 2; ILBT 2013, p. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187). However, it remains uncertain whether the demographic and genetic health and persistence of populations in the DPS depend on regular or intermittent immigration of lynx from Canada and if so to what extent (McKelvey *et al.* 2000a, pp. 241-242; 79 FR 54793).

2.2.1 Ecological Requirements of Individuals

From birth through recruitment of at least one of it's progeny into the breeding population, the ecological requirements of an individual lynx are met if:

1) its mother occupies a home range containing
    a) secure denning habitat,
    b) adequate prey abundance (especially snowshoe hares) to support lactation during the early kitten stage and later provisioning of the kitten with meat,

c) habitat (boreal forest and snow) conditions that reduce the likelihood and effect of competition from other hare predators, and
d) a low likelihood of encounters with lynx mortality agents (predators, traps, vehicles, etc.);

2) its mother's home range occurs within a larger landscape that also contains adequate hare abundance and available habitat into which the yearling lynx may disperse and establish its own home range after the period of maternal dependence, with low likelihood of adverse competition or mortality; and

3) the larger landscape also supports other secure lynx home ranges and ensures the opportunity to encounter a lynx of the opposite sex, breed successfully, and contribute to the recruitment of at least 1 offspring into the breeding population during its lifetime.

In cyclic lynx populations in the core of the species' range (northern Canada and Alaska), there is a strong element of timing that determines whether these individual needs will be met. During the decline and low phases of the hare population cycle, few or no kittens are born, very few survive until their first winter, and recruitment may collapse completely or nearly so for several successive years (Slough and Mowat 1996, entire; Mowat *et al.* 2000, pp. 266, 285-287). Therefore, even in the core of the species' range, a kitten born during a period of declining or low hare abundance is very unlikely to survive to independence, breed successfully, and replace itself within the breeding population in its lifetime. Conversely, a kitten born during the increase or high phase of the hare population cycle is much more likely to survive and, therefore, have an opportunity to breed successfully and replace itself via recruitment of 1 or more of its offspring into the breeding population.

At the southern periphery of the lynx's range (southern Canada and the contiguous United States), hare population cycles are of lower amplitude or absent (Hodges 2000a, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016a, pp. 16-17), hare densities are typically on the lower end of densities reported for northern populations, and lynx abundances and demographic rates in the south are typically like those of northern lynx populations during hare lows (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367). Therefore, in southern populations the likelihood is probably relatively low that an individual lynx will have its ecological requirements met sufficiently to replace itself in the breeding population. Also in the south, there are more diverse assemblages of potential competitors and predators, more natural patchiness and anthropogenic fragmentation of lynx habitat (fewer areas with adequate hare densities and favorable snow conditions distributed broadly across large landscapes), and higher road densities and, thus, greater potential for lynx-vehicle collisions (Wolff 1980, p. 128; Buskirk *et al.* 2000a, entire). These factors probably further reduce the likelihood that an individual lynx in the southern periphery of the range will survive, reproduce successfully, and have 1 or more offspring recruited into the resident breeding population.

Individual lynx require large areas (tens to hundreds of square kilometers) of boreal forest landscapes to support their home ranges, provide hares in adequate abundance to meet their

nutritional needs, provide breeding opportunities, and facilitate dispersal and exploratory travel. Female home ranges must also provide secure denning habitat in close proximity to foraging areas with high hare densities to allow females to adequately provide for dependent kittens (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). The size of lynx home ranges is strongly influenced by the quality of the habitat, particularly the abundance of snowshoe hares, in addition to other factors such as gender, age, season, and density of the lynx population (Aubry *et al.* 2000, pp. 382–385; Mowat *et al.* 2000, pp. 276–280). Generally, females with kittens have the smallest home ranges, likely related to their need to stay close to dens and dependent kittens, and males have the largest home ranges (Moen *et al.* 2005, p. 11; Burdett *et al.* 2007, p. 463; ILBT 2013, p. 24).

The increased natural patchiness and fragmentation of high-quality hare habitat where boreal forest conditions transition to temperate forest types require individual lynx in many parts of the DPS to maintain relatively large home ranges that include patches of higher hare densities within a matrix of lower-quality habitats with lower hare densities (ILBT 2013, p. 126; 78 FR 59434; also see 2.3.3). Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range (78 FR 59438). Annual home range sizes reported for lynx in the contiguous United States (table 3) vary greatly across the DPS but are generally larger in the west than the east; however, differences should be interpreted with caution because different methods, sample sizes, and estimators were used to generate them (ILBT 2013, pp. 23-24; also see footnotes to table 3, below).

Table 3. Reported annual home range sizes for Canada lynx in the contiguous United States.

Geographic Unit	Mean or Median Annual Lynx Home Range Size km^2 (Range)		References (Page Nos.)
	Female	Male	
N Maine	25-33 (14-70)	39-60 (24-102)	Vashon *et al.* 2008a (1482)[1]; Mallett 2014 (169)[2]
NE Minnesota	17-87 (13-122)	160-267 (86-439)	Mech 1980 (263-265)[3]; Burdett *et al.* 2007 (460-463)[4]; Moen *et al.* 2008b (17)[4]
NW Montana/ NE Idaho	43-90 (11-157)	122-220 (29-552)	Brainerd 1985 (20)[5]; Squires and Laurion 2000 (343-344)[3]; Squires *et al.* 2004a (13, table 6)[6]
N-C Washington	37-91 (37-91)	49-69 (29-99)	Brittell *et al.* 1989 *in* Stinson 2001 (5)[7]; Koehler 1990a (847)[7]; Maletzke *in* Lynx SSA Team 2016a (21)[7]
GYA	50-105 (32-105)	116-824 (98-2,181)	Squires and Laurion 2000 (343-344)[3]; Squires *et al.* 2003 (12-13)[6]
W Colorado	75-704 (NA)	103-387 (NA)	Shenk 2008 (10)[2]

[1]85% fixed kernel; [2]90% fixed kernel; [3]95% minimum convex polygon (MCP); [4]95% MCP and 95% fixed kernel; [5]Minimum area method; [6]95% fixed kernel; [7]100% MCP.

Juvenile and adult lynx require about 400 and 600 grams (14 and 21 ounces) of food per day (for adults, 0.4-0.5 hares/day, 170-200 hares/year), respectively, to meet their basic nutritional requirements (Saunders 1963, p. 390; Nellis *et al.* 1972, pp. 324-325). Several sources (Ruggiero *et al.* 2000b, pp. 446-447; ILBT 2013, pp. 26, 125) have suggested that landscape-level hare densities ≥ 0.5 hares/ha (0.2 hares/ac) are necessary to support lynx home ranges and resident breeding populations. Lynx home range abandonment, dispersal, and mortality increase when hare densities are lower, and lynx may be unable to survive where landscape hare densities are below 0.3 hares/ha (0.12 hares/ac; Ward and Krebs 1985, pp. 2819-2822; Slough and Mowat 1996, entire). Recent research in the contiguous United States generally supports the 0.5 hares/ha threshold. For example, in northern Maine, areas with average landscape hare densities of 0.74 hares/ha (0.30 hares/ac) supported resident breeding lynx, but areas with hare densities below 0.5 hares/ha (0.2 hares/ac) were not occupied by lynx (Simons-Legaard *et al.* 2013, pp. 567, 574-575). In northeastern Minnesota, resident lynx maintained home ranges where landscape hare densities were 0.64 hares/ha (0.26 hares/ac), but nearby Voyageurs National Park, where hare density was estimated at 0.35 hares/ha (0.14 hares/ac), did not support resident breeding lynx (Moen *et al.* 2012, pp. 352–354). Similarly, in western Montana, resident lynx used dense young forest stands with mean summer and winter hare densities of 0.64 hares/ha (0.26 hares/ac) and 0.47hares/ha (0.19 hares/ac), respectively, and dense mature multi-story stands in winter when mean hare density was 0.53 hares/ha (0.21 hares/ac), but they did not use more open young or mature stands where hare densities ranged from 0.12 - 0.20 hares/ha (0.05 - 0.08 hares/ac; Squires and Ruggiero 2007, pp. 313-314).

Steury and Murray (2004, p. 137) suggested minimum hare densties of 1.1 - 1.8 hares/ha (0.45 - 0.73 hares/ac) would be necessary to support lynx reintroduction efforts in the southern portion of the range, but Murray *et al*. 2008 (p. 1468) acknowledged that threshold could be overly conservative if southern lynx are less reliant on hares (i.e., more reliant on alternate prey) or if southern hare numbers are more stationary so that resident lynx numbers in the south do not fluctuate as dramatically as is typical in northern populations. Indeed, more than 10 years after translocations of Canadian and Alaskan lynx ceased, resident lynx continue to occupy parts of western Colorado, where hare densities are generally much lower, and lynx there rely heavily on red squirrels, which accounted for 23 ± 6 percent (annual range = 0.1 to 66 percent) of prey items identified over 11 winters (Shenk 2009, pp. 16, 24).

In addition to adequate hare density, individual lynx require landscapes in which they are unlikely to encounter animals that may prey on them or suffer reduced fitness from competition with other hare predators. As described above, the lynx has a much lower foot-loading than most of its potential predators and competitors, and this is believed to provide an advantage in places that receive deep and persistent unconsolidated snow. Although specific snow requirements for lynx (amount/depth, quality, persistence) have not been quantified throughout the DPS range, historical lynx occurrence records in the contiguous United States were correlated with areas that received at least 4 months (December through March) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Where snow conditions do not consistently favor

lynx, increased potential for predation and competition would be expected (Peers *et al.* 2013, p. 8). Finally, individual lynx are more likely to survive, breed, and replace themselves in the breeding population if they occupy home ranges where trapping is prohibited or trapping pressure is low (Slough and Mowat 1996, entire), high-speed/high-volume roadways are absent (ILBT 2013, pp. 77-78), and other potential anthropogenic causes of lynx mortality are absent or minimal.

In summary, individual lynx require large landscapes with hare densities that maximize their chances of (1) surviving to independence, (2) establishing and maintaining a home range, (3) breeding successfully, and (4) contributing genes to future generations (Breitenmoser *et al.* 1993, p. 552). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. The available science, including recent research in the DPS range, suggests that landscape-level hare densities consistently ≥ 0.5 hares/ha (0.2 hares/ac) and favorable snow depth and conditions for about 4 months are needed to support lynx occupancy, reproduction, and recruitment. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or do so inconsistently.

2.2.2 Ecological Requirements of Populations and the DPS

Lynx populations require essentially the same things that individual lynx do, but on a larger landscape with hare densities and habitat conditions capable of consistently supporting multiple home ranges, breeding and dispersal opportunities, and reproductive and survival rates such that recruitment and immigration will, on average over the long term, equal or exceed mortality and emigration (Pulliam 1988, pp. 652-654). To support persistent lynx populations, such landscapes must provide for the survival of at least some resident lynx even when hares are least abundant and/or other habitat features (e.g., snow conditions) are least favorable so that the lynx population can recover, perhaps aided by immigration, when hare numbers and/or other habitat conditions improve. As with individual lynx, populations are more likely to persist in landscapes where the effects of competition, predation, and human-caused mortality (e.g., trapping, vehicle collisions) are relatively lower.

In a metapopulation structure like that thought to govern lynx population dynamics, the persistence of peripheral populations is determined by colonization and extinction rates (McKelvey *et al.* 2000b, p. 25). Colonization is driven by the number of populations, the distances between them, and the species' dispersal capabilities and timing. Extinction rates are determined by population size and demographic and environmental stochasticity, with extinction more likely in smaller and more isolated populations (McKelvey *et al.* 2000b, pp. 25-31). Formal population viability analyses (PVAs) have not been published for most lynx populations in the DPS and may not be possible for some populations given limited data and natural temporal variation in demographic rates (McKelvey *et al.* 2000b, pp. 22, 30). Although some demographic data are available for most lynx populations in the DPS, most are limited to relatively few, small study areas or relatively short durations. There remains uncertainty about whether, and if so to

what extent, the demographic health of DPS populations relies on immigration from northern (Canadian) populations; and immigration rates are not known for DPS populations (McKelvey *et al.* 2000b, pp. 24-34). These factors likely preclude development of meaningful DPS-wide or unit-specific empirical population viability models (McKelvey *et al.* 2000b, p. 22).

In the core of the species' range in the southern Yukon, Slough and Mowat (1996, p. 952, table 4) calculated a lynx population growth rate (lambda, λ) = 2.03 (annual doubling) during the 4-year increase-to-peak phase of the hare cycle. This period of rapid growth was followed by a rate of λ = 1.01 (stable) during the first year of a hare decline, and λ = 0.10 and λ = 0.46 (rapid decline) during the first 2 years of the lynx population decline when hares were scarce. However, the natural range in λ that would be expected among peripheral, isolated, or semi-isolated lynx populations where hares are non-cyclic or weakly-cyclic (i.e., in DPS and some southern Canadian populations; Murray 2000, pp. 1210-1215; Murray 2003, pp 152-155), versus those that would signal long-term population decline or instability is unknown. Despite this, and the limitations noted above, Squires (*unpubl. data in* Lynx SSA Team 2016a, p. 20) calculated population growth rates in northwestern Montana of λ = 0.92 for lynx in the Seeley Lake area (i.e., declining population trend, 1999-2007) and λ = 1.16 for lynx in the Purcell Mountains (increasing trend, 2003-2007). Likewise, MDIFW in 2012 calculated an intrinsic rate of growth of 0.05 (λ = 1.05) for Maine's lynx population based on demographic data from a radiotelemetry study collected over a 12-year period (Vashon *et al*. 2012, Appendix VI). Neither the Montana nor Maine estimates incorporated rates of immigration/emigration (i.e., both assumed immigration and emigration rates of zero, which is very unlikely and contradicted by historical and recent evidence of lynx dispersal in both directions across the Canada-Unites States border across the DPS range). Schwartz (2017, p. 4) noted that very low immigration rates (less than 1 female/year on average for a theoretical population of 100 lynx) could provide population stability or even growth, suggesting that the Seeley Lake population and perhaps other DPS populations are probably being bolstered by low levels of immigration, which may go undetected. Other efforts to model lynx population dynamics in the DPS range include those of Lyons *et al*. (2016, entire), who developed spatially-explicit, individual-based population models to estimate reductions in potential lynx carrying capacity in Washington associated with recent large wildfires, and Licht *et al*. (2017, *in press*, entire), who conducted a PVA of a potential lynx reintroduction to Isle Royale in Lake Superior, about 22 km (14 mi) east of Unit 2.

Although minimum viable population sizes have not been derived for lynx populations in the DPS, the Service's Recovery Outline (USFWS 2005, p. 5) suggested landscapes of at least 1,250 km^2 (483 mi^2) with sufficient boreal/subalpine habitat, hare densities, and snow conditions favorable for lynx. These are the minimum landscape size and habitat conditions thought necessary to support a minimum lynx population of at least 25 adults based on a density of 1 lynx per 50 km^2 (USFWS 2005, p. 5). McKelvey *et al.* (2000b, p. 29) noted that extinction (extirpation) risk should decrease with increasing population size, and that extinction resulting from demographic stochasticity is very unlikely even for a population (generally; not specific to lynx) with as few as 20 reproducing females. Kramer-Schadt *et al.* (2005, entire) developed a spatially explicit population model for Eurasian lynx in Germany which they combined with demographic scenarios to evaluate the likely success of potential reintroduction efforts; they

concluded that at least 10 females and 5 males would be required to establish a population with an extinction probability less than 5 percent over 50 years. Rodriguez and Delibes (2003, entire) evaluated extinction among populations of Iberian lynx; they found that extinction occurred only in small populations that occupied habitats of less than 500 km^2 and that extinction within 35 years was unlikely among populations occupying areas of at least 500 km^2 of adequate habitat quality.

In summary, lynx populations need large (thousands of square kilometers) boreal forest landscapes with hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low. These landscapes also must have snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term. Immigration may be particularly important to the persistence and stability of lynx populations at the southern periphery of the range, including those within the DPS, where hare densities are generally low and hare populations are either non-cyclic or weakly-cyclic compared to northern populations. Low hare densities reduce the likelihood that lynx recruitment will consistently equal or exceed mortality, and non-cyclic or weakly-cyclic hare populations are unlikely to allow the rapid lynx population recovery observed in northern lynx populations when hare numbers increase dramatically after cyclic population crashes. Conversely, more stable hare populations, even at lower landscape-level densities, likely provide stability (i.e., prevent periodic steep declines) among lynx populations on the periphery of the range in the DPS and in southern Canada. Although immigration rates for DPS populations are unknown, as is the rate and periodicity of immigration needed to provide demographic stability among them, connectivity with and immigration from lynx populations in Canada are believed to be important to the persistence of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; USFWS 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789).

2.3 Historical and Current Lynx Distribution

2.3.1 Lynx Distribution and Status in Canada and Alaska

The Canada lynx is broadly distributed across northern North America from eastern Canada to Alaska (McCord and Cardoza 1982, p. 729; Poole 2003, p. 361; Vashon 2015, p. 4; Univ. of Alaska Center for Conservation Science 2016, p. 1). It is strongly associated with the expansive, continuous boreal forests of those areas, and its range largely overlaps that of its primary prey, the snowshoe hare, also a boreal forest specialist (Bittner and Rongstad 1982, p. 146; Mowat *et al.* 2000, pp. 268-269; Aubry *et al.* 2000, p. 375). In Canada, lynx are thought to occupy about 5.5 million km^2 (over 2.1 million mi^2), which represents 95 percent of their historical range in that country (Environment Canada 2014, p. 2), and over 89 percent of the species' entire distribution. Nationally in Canada, lynx are classified as secure, widespread, and abundant; they are managed for long-term population stability, with a conservative estimate of 110,000

individuals during cyclic lows; and no acute, widespread threats to lynx have been identified (Environment Canada 2014, entire; Vashon 2015, pp. 1-6). Provincially, lynx status is considered secure in British Columbia, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Northwest Territories, and the Yukon; sensitive in Alberta and Saskatchewan; at risk/endangered in New Brunswick and Nova Scotia; and undetermined in Nunavut (Environment Canada 2014, pp. 3-4; Vashon 2015, p. 1). Lynx were extirpated from Prince Edward Island (0.1 percent of lynx range in Canada) by the late 1800s, and on the mainland the southern margin of assumed lynx range has contracted northward in Quebec, southeastern Ontario, Manitoba, Saskatchewan, and Alberta (Poole 2003, p. 361; Bayne *et al.* 2008, pp. 1192-1195; Koen *et al.* 2014a, pp. 757-760).

In Alaska, lynx are distributed across roughly 534,454 km^2 (206,354 mi^2) of boreal forest (Univ. of Alaska Center for Conservation Science, 2016, entire; Reimer 2016, *pers. comm.*), which represents about 8.7 percent of the species' breeding distribution. Lynx in Alaska are apparently secure, with low to moderate threats, and populations appear stable statewide, although total abundance is unknown (Alaska Natural Heritage Program 2008, pp. 2-4).

In both Alaska and Canada, lynx trapping is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the lynx-hare population cycle (Alaska Natural Heritage Program 2008, pp. 2-6; Vashon 2015, pp. 5-6). Along the Canada-United States border in provinces adjacent to DPS lynx populations, lynx trapping is prohibited in New Brunswick (adjacent to northeastern Maine) but regulated trapping is permitted in Quebec (adjacent to northwestern Maine, northern New Hampshire, and northern Vermont), Ontario (adjacent to northeastern Minnesota), Alberta (adjacent to northwestern Montana), and British Columbia (adjacent to northwestern Montana, northern Idaho, and northern Washington). Because after 2 centuries of being legally harvested for the international fur trade it remains widespread and abundant over most of its range, and because managed harvest in recent decades does not appear to have caused significant range loss or population decline, the lynx has been designated a "species of least concern" in accordance with the IUCN Red List of Threatened Species (Vashon 2015, entire).

2.3.2 Lynx Distribution in the Contiguous United States

2.3.2.1 Defining Lynx Distribution at the Periphery of the Range

Several aspects of lynx population dynamics and dispersal patterns have resulted in inconsistent approaches and difficulty in defining the range and/or distribution of the species, especially at the margins (74 FR 66942). There also is uncertainty and ambiguity in some historical lynx occurrence records, with early assessments based largely on trapping harvest records of questionable accuracy, particularly where lynx and bobcats overlap, and a reliance on anecdotal or unverified occurrence information (McKelvey *et al.* 2000a, pp. 208-210; 65 FR 16054). These issues confound efforts to accurately portray the species' historical distribution in the contiguous United States and to assess the current distribution relative to historical conditions (McKelvey *et al.* 2008, pp. 553-554; 79 FR 54814-54815; McKelvey *in* Lynx SSA

Team 2016a, p.11). This has resulted in inaccurate portrayals of lynx distribution and misperceptions that the historical range of lynx in the contiguous United States was once much more extensive than is ecologically possible (68 FR 40080; 74 FR 66942).

The boreal forest reaches its southern extent in the northern contiguous United States and it becomes naturally patchy and marginal for hares and lynx in places where it transitions to temperate forest types. Many areas of boreal or boreal-like (spruce-fir) forest (e.g., the Appalachian Mountains from New York southward in the East, most of northern Michigan and northern Wisconsin in the Midwest, and the Southern Rocky Mountains and Southern Cascade Mountains in the West) probably never supported persistent native lynx populations despite the presence of snowshoe hares. Hare densities in these areas are generally low and appear insufficient to support resident lynx populations over time. Only a relatively few areas in the contiguous United States historically supported an adequate quantity, quality, and spatial arrangement of habitat to support resident lynx populations continuously over time, and many historical lynx occurrences across a large area of the contiguous United States were likely dispersers. The occurrence of dispersing lynx is unpredictable, and dispersing lynx will probably continue to move periodically and temporarily into areas that cannot support persistent populations (68 FR 40077).

Because the lynx is highly mobile and has, throughout most of its range, cyclic population dynamics that are closely tied to cyclic snowshoe hare populations, numbers of lynx naturally fluctuate and become extremely low during lows in decadal hare cycles. The dramatic, cyclic fluctuations in lynx populations across much of the range as they track cyclic hare populations and the mass synchronous dispersals (irruptions) of large numbers of lynx into the contiguous United States when northern hare populations crashed are well-documented (Elton and Nicholson 1942, entire; Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 219, 232-242; Mowat *et al.* 2000, pp. 281-294; ILBT 2013, p. 33). These events have resulted in records of lynx occurrence, in some cases very rarely, in other cases sometimes in large numbers and with intermittent (cyclic) regularity, in places that otherwise lack evidence of persistent lynx presence or the habitats and hare densities necessary to support a resident lynx population (USFWS 2005, pp. 3-4; 79 FR 54787-54789, 54793-54795, 54812-54823).

Many records of lynx in the contiguous United States appear to be related to such events, including the unprecedented ‘‘explosions’’ of lynx observed in the early 1960s and 1970s (Gunderson 1978, entire; McKelvey *et al.* 2000a, pp. 232-242). During these events, many lynx occurred in anomalous habitats, exhibited unusual behavior, suffered high mortality, and numbers declined dramatically within a few years of irruptive peaks (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, p. 242). Because dispersing lynx typically do not persist in these areas of temporary range expansion, disappearing fairly quickly after irruptions, van Zyll de Jong (1971, p. 16) suggested that only areas that support lynx populations throughout both the low and the high phases of the “10-year cycle” (i.e., across the natural range of hare densities) should be considered to constitute the species’ range. In its 2003 remanded determination, the Service determined that lynx in the contiguous United States exist either as resident populations or as dispersers, that dispersing lynx are often found repeatedly

and for variable amounts of time in habitats that cannot sustain breeding populations over time (though some breeding may occur occasionally in some of these areas), and that such areas probably contribute little (if at all) to the persistence of lynx in the DPS (68 FR 40077, 40079-80). This repeated dispersal into habitats that ultimately cannot support the species (‘‘sink’’ habitats) often leads to confusion about where lynx populations may be viable (74 FR 66938).

The metapopulation structure thought to govern lynx populations in the DPS (McKelvey *et al.* 2000b, pp. 25-31; see Section 2.2) and the transitional (and, therefore, increasingly fragmented and isolated) and spatially- and temporally-shifting nature of lynx habitat at the southern periphery of the range (Koehler and Aubry 1994, pp. 78-79; McKelvey *et al.* 2000b, pp. 29-30; 74 FR 66940; 79 FR 54814) also present challenges in defining the distribution of lynx. Both factors suggest that some areas may naturally support resident lynx only temporarily or occasionally when habitat conditions (both boreal forest vegetation supporting abundant hares and snow conditions favoring lynx) are adequate and/or when immigration is sufficient to offset the lower productivity and recruitment rates expected among lynx populations in marginal or suboptimal habitats. McKelvey *et al.* (2000b, pp. 21, 29-31) described such habitats as “... source-sink mosaics that shift with disturbance and succession,” and the contribution, if any, of these places (especially those that act more often as “sinks” than “sources”) to the maintenance and persistence of lynx populations in the DPS remains questionable (74 FR 66938).

Finally, the southern periphery of the lynx’s range, where lynx are rare in many places, overlaps with the northern distribution of the much more common bobcat (Peers *et al.* 2012, pp. 4-5). The 2 species are difficult to distinguish in the field, they often were not reliably differentiated in historical trapping records (McKelvey *et al.* 2000a, pp. 208-209), and errors in early accounts of lynx distribution based on anecdotal information seem likely (Halfpenny and Miller 1980, pp. 1, 3-8; Meaney 2002, pp. 3-5, Hoving *et al.* 2003, pp. 366-367). Because of the large effect that relatively few errors in identification can have on assessments of the distribution of rare animals, McKelvey *et al.* (2000a, p. 209; 2008, pp. 553-554) suggest that anecdotal information should be interpreted with caution, and only verified occurrence data should be used to assess historical and current lynx distributions.

These complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with a naturally dynamic and transitional habitat, make it difficult, if not impossible, to precisely delineate the historical or current distribution of resident lynx populations in the contiguous United States (Koehler and Aubry 1994, p. 79; 68 FR 40084). While recognizing these limitations, we use our best professional judgment of the best scientific and commercial data available to make conclusions about the range of the lynx for the purposes of this SSA. In the following section, we describe the types and distributions of potential lynx habitats in the contiguous United States, and our current understanding of the historical and current distributions of resident lynx populations in the DPS considering the factors discussed above.

2.3.2.2 Lynx Distribution within the DPS Range

The southern periphery of boreal forest vegetation extends into parts of the northern contiguous United States, where it transitions to the Acadian forest in the Northeast (Seymour and Hunter 1992, pp. 1, 3), deciduous temperate forest in the Great Lakes region, and subalpine forest in the Rocky Mountains and Cascade Mountains in the west (Agee 2000, pp. 40-41). In much of the DPS range, these boreal forest landscapes become naturally patchy and transitional because they are at the southern edge of the boreal forest range, and they are limited, particularly in the west, by elevation and/or aspect (Ruediger *et al.* 2000, p. 4-16; 68 FR 40090). Non-forested land uses (e.g., agriculture, development) become increasingly prevalent in these areas. These factors generally limit snowshoe hare populations in the contiguous United States from achieving landscape densities similar to those of the expansive northern boreal forest in Alaska and Canada, where hares are generally more evenly distributed across the landscape and more abundant except during cyclic population lows (Wolff 1980, pp. 123-128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990a, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373-375, 382, 394). Consequently, important foraging habitat for lynx is often more limited and fragmented in the contiguous United States than in boreal forests of northern Canada and Alaska (Berg and Inman 2010, p. 6), and overall habitat quality is typically lower.

The habitats that lynx use in the contiguous United States are characterized by patchily-distributed moist forest types with relatively higher hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with lower landscape hare densities (ILBT 2013, p.126; 78 FR 59434). In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support higher hare densities where most lynx foraging occurs. In some areas, patches of habitat containing snowshoe hares become so small and fragmented that the landscape cannot support lynx home ranges (ILBT 2013, p. 77) or populations over time (68 FR 40077). Additionally, the presence of more snowshoe hare predators and potential lynx competitors at southern latitudes may inhibit the potential for high-density hare populations (Wolff 1980, p. 128). Wirsing *et al*. (2002, entire) concluded that high predation rates on hares in fragmented habitats may explain the relative stability (i.e., lack of cyclicity) in southern hare populations. As a result, lynx in the DPS generally occur at relatively low densities compared to lynx in the core of the Canadian and Alaskan range when hares are abundant (Aubry *et al.* 2000, pp. 375, 393-394). Because the lynx is a habitat and prey specialist, its densities in the DPS range are also typically lower than those of the bobcat, which is a habitat and prey generalist (Peers *et al*. 2012, pp. 4-9).

Snow conditions also are thought to influence lynx distribution (Ruggiero *et al.* 2000b, pp. 445-449; Peers *et al.* 2012, pp. 4-9) because they are morphologically and physiologically well-adapted for hunting snowshoe hares and surviving in areas that have cold winters with deep and persistent unconsolidated snow (Murray and Boutin 1991, p. 463). Long-term snow conditions also presumably limit the winter distribution of potential lynx competitors and

predators (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, p. 123; Peers *et al.* 2012, entire; also see section 2.2 above), although behavioral adaptations may offset morphological differences to some degree (e.g., Murray *et al*. 1994, entire; 1995, entire).

Based on verified data, lynx were documented historically in 24 of the contiguous United States (McKelvey *et al.* 2000a, 207-232). More recently, lynx have been documented in 3 other states after some of the lynx released into southwestern Colorado (see below) dispersed into northern New Mexico, Arizona, and Kansas (Colorado Division of Wildlife 2000, p. 3; Devineau *et al.* 2010, p. 526; 74 FR 66938), which had previously lacked verified evidence of lynx occurrence (McKelvey *et* al. 2000a, p. 210; USFS 2009, entire; 74 FR 66940-66943). However, in many states, lynx occurred very rarely as dispersers and often in anomalous habitats – usually (as described above) in association with “irruptions” (mass dispersal events) of lynx from Canada when northern snowshoe hare populations underwent dramatic cyclic declines roughly every decade. Based on our current understanding of lynx and hare habitat requirements, the Service concludes that records in at least 13 states (Arizona, Connecticut, Illinois, Indiana, Iowa, Kansas, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Pennsylvania, and South Dakota) represent occasional dispersing lynx that arrived in places with no historical or recent evidence of the habitat quality, quantity, or distribution necessary to support resident lynx (68 FR 40099; 74 FR 66940-66942; 79 FR 54807, 54817). These states are not within the distribution of resident lynx in the DPS, and we conclude that they naturally lack the necessary habitat, hare densities, and snow conditions and that they were not capable historically, and are not capable now, of supporting resident lynx populations over time.

When it listed the DPS under the ESA, the Service defined its range as the forested portions of the remaining 14 states; 4 in the Northeast (Maine, New Hampshire, New York, Vermont), 3 in the Great Lakes Region (Michigan, Minnesota, Wisconsin), and 7 in the West (Colorado, Idaho, Montana, Oregon, Utah, Washington, Wyoming; 65 FR 16052, 16085). Some of these states, and parts of others, are thought to have historically supported only dispersing lynx or to have only occasionally supported resident breeding lynx (68 FR 40099; 74 FR 66940). Such areas were included within the range of the DPS because of the possibility that lynx could establish small, local populations in them and perhaps contribute to the persistence of the DPS, though evidence of this was (and remains) lacking (68 FR 40080; 74 FR 66938).

Based on a comprenhensive, peer-reviewed analysis of verified historical lynx records that was published at about the time the DPS was listed (McKelvey *et al.* 2000a, entire) and on research and monitoring that have occurred since then, it seems likely that lynx occurred historically in some states (New York, Vermont, Wisconsin, Oregon, and Utah) only intermittently as dispersers or as small, naturally ephemeral populations; not as persistent resident breeding populations. In other states (New Hampshire, Michigan, Colorado, and Wyoming), it remains uncertain whether resident lynx occurred historically as small but persistent breeding populations or only ephemerally. Parts of the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) show the strongest evidence of historical and recent (at the time of listing and since then) persistent resident populations.

In its 2003 remanded determination for the lynx DPS, the Service concluded that (1) potential lynx and hare habitats in Michigan, Oregon, Utah, Vermont, and Wisconsin were relatively small, isolated, and of marginal quality, and that available information suggested that these states did not historically or recently support resident lynx populations; (2) it was uncertain whether Colorado, New York, and Wyoming historically supported resident populations or only occasional dispersers; (3) New Hampshire probably supported a small resident population that had been extirpated; and (4) the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) had the best historical and recent evidence of resident breeding populations (68 FR 40082, 40086-40095, 40097-40101). Below we provide our current understanding of these state groupings and the information available since the 2003 remand that informs this understanding.

Michigan, Oregon, Utah, Vermont, and Wisconsin - Additional information and analyses available since 2003 support the determination that Michigan (except for Isle Royale in Lake Superior) and Oregon did not historically or recently support resident lynx populations (Aubry 2006, pp. 1-2; Linden 2006, pp. 83-90), and no evidence has emerged to suggest that resident populations occurred historically or recently in Utah or Wisconsin (ILBT 2013, pp. 45, 58). Isle Royale, a 535-km^2 (206-mi^2) island in northwestern Lake Superior that is closer to northeastern Minnesota and southern Ontario than to the rest of Michigan, is thought to have historically supported a small (perhaps 30 lynx) population that was extirpated in the 1930s due to overtrapping (Licht *et al.* 2015, p. 139; 2017, p. 505). The best available information continues to suggest that the rest of Michigan, as well as Oregon, Utah, and Wisconsin, did not historically, and do not currently, support resident lynx populations. We conclude that (1) habitats in these states are naturally incapable of supporting persistent resident populations; (2) historical and potential future occurrences of lynx in these states most likely represent occasional dispersing lynx; and (3) these states (with the possible except of Isle Royale, MI) have not historically or recently contributed to the persistence and conservation of lynx in the DPS and are unlikely to do so in the future.

In contrast, 9 lynx occurrences were confirmed in the 530-km^2 (205-mi^2) Nulhegan Basin of northeastern Vermont from 2003 to 2014, and breeding was confirmed in 2012; intensified surveys since then have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). This new information indicates that this small area of northernmost Vermont is at least occasionally capable of supporting a small number of resident breeding lynx. However, assessments of the amount and quality of potential lynx and hare habitat, snow conditions, and the presence and distribution of lynx competitors and predators (Hoving *et al.* 2005, pp. 746-749; Bernier 2015, entire) indicate it is unlikely that northern Vermont can support a persistent resident lynx population (79 FR 54820-54821). We conclude that this small area of Vermont only occasionally supports lynx reproduction when hare abundance and snow conditions are temporarily adequate; that it most likely represents a “sink” rather than a “source” for the regional lynx population; and that this likely represents its natural historical condition.

Colorado, New York, and Wyoming - When the Service listed the DPS in 2000, it believed that a resident lynx population occurred historically in the Southern Rocky Mountains of western Colorado and southeastern Wyoming, that lynx were also historically resident in northwestern Wyoming (part of the Northern Rocky Mountains), and that the Adirondack Mountains of northern New York may historically have supported a resident population that was extirpated by the latter half of the 1900s (65 FR 16055-16056; 16058-16059). In the 2003 remand, the Service noted inconsistencies and likely errors in historical lynx reports for the Southern Rockies, questioned its original conclusion that Colorado historically supported an isolated resident population, and concluded that it was uncertain whether a resident population occurred historically in Colorado or if historical records were of periodic dispersing lynx during "extremely high population cycles" and that a resident population never existed in southeastern Wyoming (68 FR 40081, 40091). In that rule, the Service also concluded that, despite evidence of reproduction in northwestern Wyoming (part of the GYA), potential habitat there is naturally marginal (patchier and composed of drier forest types), may be incapable of supporting a resident lynx population, and that lynx in northern Wyoming are most likely dispersers (68 FR 40090). Also in 2003, the Service concluded that it was possible resident lynx occurred in northern New York prior to 1900 but the potential habitat there is small, marginal, isolated and likely has only supported dispersing lynx since then (68 FR 40086-40087).

In Colorado, after the initial release of 96 lynx in 1999 and 2000, none were released in 2001 or 2002 (Shenk 2010, pp. 1, 4; Ivan *in* Lynx SSA Team 2016a, p. 22). From 2003-2006, another 122 lynx were released, bringing the total to 218 (Devineau *et al.* 2010, p. 526). Reproduction was documented in 2003-2006 and 2009-2010, with 48 dens documented in that time, including a third generation of Colorado-born lynx (Shenk 2010, p. 5; Ivan *in* Lynx SSA Team 2016a, p. 22). In 2010, CPW determined that all benchmarks for its lynx program had been met and had resulted in the establishment of a viable, self-sustaining lynx population (Ivan 2011b, pp. 11, 12). Intensive monitoring of the population ceased in 2010 and was replaced by an effort to develop a minimally-invasive long-term monitoring program (Ivan 2011b, entire), which used snow-tracking surveys and camera traps to document continued lynx presence in the core release area of the San Juan Mountains in 2010-11, 2014-15, and 2015-16, with evidence of reproduction also documented during that time (Ivan *et al*. 2015, p.1; Odell *et al*. 2016, entire). In its 2014 revised critical habitat designation for the DPS, the Service concluded that the historical record of verified lynx occurrence in Colorado combined with naturally highly-fragmented and isolated potential habitat and generally low snowshoe hare densities suggest that Colorado and the Southern Rockies were unlikely to have historically supported a persistent resident lynx population and that the long-term persistence of the introduced population is uncertain (79 FR 54787-54789, 54793-54795, 54816-54817). The current size of the resident lynx population in Colorado is unknown but thought to number between 100 and 250 (Ivan *in* Lynx SSA Team 2016a, p. 47). We continue to believe that available information suggests Colorado did not historically support a persistent resident lynx population and that the long-term persistence of the introduced population remains uncertain.

In northern New York, 83 lynx were released into the Adirondack Mountains in 1988-1990 (Brocke et al. 1993, p. 1); however, that effort failed to establish a resident breeding population

(65 FR 16055), suggesting that potential habitat there may be (and historically may have been) inadequate to support lynx persistence (68 FR 40086-40087). Information and analyses since the 2003 remand support the conclusion that New York has inadequate habitat quantity and quality (both vegetation and snow conditions) to support a resident lynx population (Hoving *et al.* 2005, pp. 746, 749). We have no information that resident lynx presently occur in New York, and our evaluation of historical records suggests that the timing of most (19; 83 percent) of the 23 verified records in the state after 1900 (McKelvey *et al.* 2000a, p. 216, table 8.2) were consistent with expected decadal irruptions of lynx from the north. The work of Hoving *et al.* (2005, entire), our evaluation of verified records of historical occurrence, and the rapid failure of the 1988-1990 lynx translocations to establish a resident population all suggest that New York has not recently and likely did not historically support a persistent resident lynx population. We conclude that (1) habitat in the Adirondack Mountains is incapable of supporting a resident lynx population, (2) verified historical records were most likely of dispersing lynx, and (3) dispersing lynx may currently and in the future continue to occur rarely and temporarily in northern New York.

In northwestern Wyoming, 18 lynx were reported to have been trapped from a small area in the Wyoming Range in winter 1971-72 (Squires and Laurion 2000, p. 338), and other sources[4] claim that 13 lynx were trapped in the Wyoming Range in winter 1972-73. However, Reeve *et al*. (1986a, Appendix A, pp. 67-69) reported no verified ("certain") records of lynx trapped from 1970-1982 and unverified ("probable") accounts that included no lynx trapped in 1971, 5 trapped in 1972, and 1 trapped in 1973. These conflicting anecdotal reports of lynx occurrence/trapping records illustrate compellingly why only verified records are appropriate for consideration of lynx historical distribution, especially given evidence of historical misidentification of bobcats as lynx (McKelvey *et al.* 2000a, pp. 208-210, 227; 2008, pp. 553-554). Even if some of these anecdotal records were correct, the large numbers of lynx reported in the early 1970s correspond to the second of 2 well-documented and unprecedentedly large irruptions of lynx from Canada into the northern contiguous United States, when dispersing/transient lynx occurred temporarily in many places with little or no evidence of the historical presence of resident lynx (McKelvey *et al.* 2000a, pp. 232-242). It is more plausible that the sudden increase in lynx reportedly trapped in the Wyoming Range suggested by some of these anecdotal records would have reflected a pulse of dispersing lynx associated with that large irruption rather than a previously undocumented resident lynx population that suddenly and simultaneously became vulnerable to trapping in only a handful of winters.

However, verified information available since 2003 has documented continued presence of a small number of lynx in northwestern Wyoming as recently as 2010, including some evidence of reproduction (Squires *et al.* 2003, entire; Squires and Oakleaf 2005, entire; Murphy *et al.* 2006, entire; Endeavor Wildlife Research 2008 and 2009, entire). Additionally, at least 9 radio-marked lynx released in Colorado subsequently moved into or through the area from 1999-2010, with several settling temporarily into parts of the Wyoming Range previously occupied by native lynx (Ivan 2017, entire; see section 4.2.5, below). More recent surveys and research-related trapping

[4] http://www.sublettecountyjournal.com/v4n16/v4n16s7.htm.

efforts have failed to detect lynx in this area or elsewhere in Wyoming since 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016a, pp. 20-21, 45).

The historical record and recent evidence of lynx occupancy and reproduction indicate that the GYA of northwestern Wyoming and southwestern Montana at least occasionally supports a small number of resident lynx. However, the consistency of lynx occupancy in the GYA over time remains uncertain (Lynx SSA Team 2016a, pp. 11, 45, 57). Uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016a, p. 57). If residency was intermittent historically, the current apparent absence of resident lynx might be a natural condition related to the area's largely marginal or suboptimal habitat conditions - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. In that case, future intermittent residency would be expected, but only if lynx dispersing from a source population immigrate to the GYA when habitat conditions and hare densities return to more favorable levels. Conversely, if the GYA always historically supported a small number of resident lynx but no longer does, it may suggest that some factor or factors have acted to shift the quality of the area's habitat from just barely capable of supporting a small resident population to no longer capable of doing so, potentially resulting in extirpation.

We conclude that this uncertainty cannot be resolved based on the available information but, given the protected conservation status of large areas of the GYA unit (Yellowstone and Grand Teton national parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie wilderness areas), its historical inability to support a robust, persistent resident population and its apparent recent inability to support any resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. We note that some of the best potential habitat and highest hare densities have been documented in areas with developmental land use designations (see 4.2.3 and 4.2.5) outside parks and wilderness (e.g., the Wyoming Range/Union Pass/Togwotee Pass areas; Squires 2017, p. 2). However, most of those areas have been managed by the USFS to conserve lynx and habitats in accordance first with the recommendations in the LCAS (Reudiger *et al*. 2000, entire) and the associated conservation agreement (CA) between the USFS and the Service (USFS and USFWS 2000, entire) and subsequently with the NRLMD (USFS 2007, entire). Nonetheless, despite active management for lynx conservation and the passage, presumably, of adequate time for some previously impacted areas to regenerate back into higher-quality hare and lynx habitats, lynx apparently have failed to naturally recolonize this unit, and released lynx dispersing from Colorado have failed to maintain long-term home ranges or produce kittens in these areas. We also note, however, that extensive areas of the GYA were burned by the large, intense wildfires of 1988, and that some of those areas may soon (perhaps in the next 5-15 years) regenerate to a stage containing the dense horizontal conifer structure favorable for hares and, therefore, lynx foraging habitat, perhaps increasing the likelihood that the GYA may support resident lynx again in the near future (Lynx SSA Team 2016a, p. 46).

In southern Wyoming, all recent lynx records are of Colorado-released lynx that moved into or through the area (Devineau *et al.* 2010, fig. 1, p. 526; Ivan 2017, entire), including 1 female that in 2004 established a den on the west side of the Medicine Bow Mountains and produced 3 kittens that did not survive (Bjornlie 2016, *pers. comm*.; Ivan 2016a, *pers. comm.;* 2017, p. 3). Based on the available information, we conclude that southern Wyoming did not historically or recently support a resident lynx population and is not now capable of doing so.

New Hampshire - There were 87 confirmed lynx records in northern New Hampshire from 2006 to 2016 (though these do not represent 87 different individual lynx), with evidence of reproduction in 2010 and 2011 (79 FR 54820; NHFGD 2017, entire). Most of these records were documented during snow-track surveys in 2012-2015, with an additional 30 lynx detections recorded in 2014-2016 by remote cameras (NHFGD 2017, entire). Most records since 2006 are in the vicinity of Pittsburg in the northernmost reaches of the state, though lynx detections in 2015 and 2016 suggest a southern expansion from the area where they had been documented in 2006 through 2014 (Siren 2016a, p. 1; Siren 2016b, *pers. comm.*). Despite recent evidence of lynx residency and reproduction, the Service concluded in the 2014 revised critical habitat designation that, based on modeling of the amount of potentially suitable habitat and favorable snow conditions (Hoving *et al.* 2005, pp. 739, 749; Litvaitis and Tash 2005, p. A-298), it is unlikely that northern New Hampshire will support a resident breeding population over the long-term (79 FR 54820-54821). Siren (2014a, p. 10) suspected that the relatively few lynx detections documented in 2012-2014 may be related to the presence and abundance of bobcat, coyote, and fisher populations in much of northern New Hampshire. We conclude that northern and central New Hampshire likely supported a small resident lynx population historically that was extirpated during the latter half of the 20th century. We are uncertain whether lynx detections in northernmost New Hampshire over the past decade may represent the natural reestablishment of a small resident breeding population in the state or if it is a temporary phenomenon related to an expanding source population in neighboring northern Maine (79 FR 54821). Although bobcat populations have increased and expanded their range in this region in recent decades (Lavoie *et al.* 2009, pp. 873-874), severe winters and deep snow can substantially limit their populations (Reed 2013, pp. 29-33; McCord, 1974, pp. 433-434). Maine's bobcat harvest declined substantially after 2 deep-snow winters in 2008 and 2009 (MDIFW 2015a, p. 37). It is possible that these anomalous deep-snow winters provided a temporary competitive advantage to lynx in northern New Hampshire.

Idaho, Maine, Minnesota, Montana, and Washington - These states (along with New Hampshire, above) have the strongest historical evidence of continuous lynx presence and recent evidence of resident lynx populations (McKelvey *et al.* 2000a, pp. 211-228; 68 FR 40086-40095, 40097-40101; McKelvey *in* Lynx SSA Team 2016a, p. 11). Historical lynx records exist for much of Idaho, but many, especially in the central and southern part of the state, occurred in anomalous habitats or were associated with large irruptions of lynx from Canada to the northern contiguous United States in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 225-227). The historical record and recent surveys (summarized at 79 FR 54818-54820) suggest that (1) only dispersing lynx occur throughout most of Idaho, (2) habitats in many parts of the state are drier forest types that support lower densities of hares, and (3) resident lynx seem to

be confined to the Purcell, Selkirk, and Cabinet mountain ranges in the State's northern panhandle. The number of individual lynx with home ranges occurring in the northeast corner of the Idaho Panhandle is unknown but small based on the amount of potential habitat and results of recent surveys (Lucid 2016, pp. 7-11; Lucid *et al*. 2016, pp. 158-160, 180), and lynx in Idaho are part of a larger population that occurs primarily in northwestern Montana and southeastern British Columbia. In the Selkirks, a single lynx was detected in 2010 and there were multiple detections in 2015-2016. Over the last several years, radio-collar data and remote camera images have documented a single lynx with a home range in the west Cabinet Mountains and there have been detections of multiple lynx in the Purcell Mountains in or immediately adjacent to designated critical habitat (i.e., within 16 km [10 mi] of the Canada border). Detections in the Purcells in 2015-2016 included a photo of an adult lynx accompanied by juvenile lynx, the only recent evidence of lynx reproduction in Idaho, which otherwise lacks evidence of a long-term, persistent resident population (IDFG 2017a, pp. 2-3).

Maine has a long history of continual lynx presence, with evidence of a persistent resident population in much of the northern half of the state (McKelvey *et al.* 2000a, pp. 211-212; Hoving *et al.* 2003, entire;), which currently is believed to support the largest lynx population in the DPS (Vashon *et al.* 2012, pp. 50-60; 79 FR 54784-54785, 54792, 54822-54824; Vashon *in* Lynx SSA Team 2016a, p. 18). The current amount and distribution of high-quality lynx and hare habitat and the numbers of hares and resident lynx in Maine are all much larger than was suspected at the time of listing or the 2003 remand, and all are probably substantially larger now than under likely typical historical conditions. Based on habitat distribution and lynx home range data, the MDIFW estimated that this geographic unit may have supported roughly 250-320 adult lynx in 1995 and 750-1,000+ by 2003-06 (Vashon *et al.* 2012, p. 58; Vashon *in* Lynx SSA Team 2016a, p. 18]), and recent information suggests that resident lynx may be expanding to the south of the core population area (Vashon 2017, *pers. comm.*). The current lynx population in Maine is supported by the broad distribution of high-quality hare habitat that resulted from extensive, large-scale clearcutting in the 1970s and 1980s in response to a massive spruce budworm (*Choristoneura fumiferana*) outbreak (68 FR 40087; 79 FR 54792; also see section 4.2.1). As these regenerating clearcuts, which currently provide the dense horizontal structure preferred by hares, mature beyond about 35-40 years post-harvest, hare densities are expected to decline as cover and forage are reduced as a result of forest succession (Simons 2009, p. 217; Simons-Legaard *in* Lynx SSA Team 2016a, p. 16). The current lynx population in Maine is probably substantially larger than typically occurred historically under the natural disturbance regime, when relatively small amounts of the spruce-fir forests in the state are thought to have been composed of the dense young stands that provode optimal hare (and, therefore, lynx foraging) habitat (Lorimer 1977, entire; 68 FR 40094; Vashon *et al.* 2012, pp. 45, 56; 79 FR 54792). With the reduction in clearcutting and the proliferation of partial harvesting following enactment of the Maine Forest Practices Act of 1989, lynx densities in Maine are projected to decline by 55 to 65 percent by 2032 (Simons 2009, p. 217; Simons-Legaard *in* Lynx SSA Team 2016a, p. 16), perhaps to levels more consistent with likely historical conditions. Lynx in Maine likely represent the southern periphery of a larger population that occurs in northern New Brunswick and southern Quebec south of the St. Lawrence Seaway/River, which appears to partially isolate lynx in this region, demographically and genetically, from populations in the core of the species'

range (Koen *et al.* 2015, entire). Whether lynx persistence in Maine relies on immigration from Canada, and if so to what extent, is unknown.

In Minnesota, research conducted since the 2003 remand has demonstrated the continuous presence of a resident lynx population in the northeastern part of the state that seems to be the southern periphery of a larger population in southwestern Ontario (Moen *et* al. 2008b, entire; Moen *in* Lynx SSA Team 2016a, pp. 19, 39). The number of resident lynx in Minnesota is unknown but believed to be between 50 and 200 (Moen *in* Lynx SSA Team 2016a, pp. 19, 39). Hare densities and snow conditions consistently favorable for lynx appear to be restricted to the northeastern "Arrowhead" region of the state. Lynx are occasionally detected to the south and west of this region; however, those areas are dominated by bobcats. Although there are currently more lynx in Minnesota than was suspected when the DPS was listed, it is unclear whether current numbers and distribution are similar to the historical condition. The extent to which lynx persistence in Minnesota may rely on immigration from Canada is also unknown.

In Montana, research conducted since the DPS was proposed for listing has documented the continued presence and broad distribution of resident lynx in much of the northwestern portion of the state (Squires *in* Lynx SSA Team 2016a, p. 20). The number of resident lynx in northwest Montana is unknown but the area is thought to be capable of supporting between 200 and 300 resident lynx (Squires *in* Lynx SSA Team 2016a, p. 41). In this area, resident lynx occur in 3 subpopulations - the Purcell Mountains, Seeley Lake/Central, and Garnet Mountains (Squires *in* Lynx SSA Team 2016a, p. 20). No lynx were detected in the Garnet Range from 2011 to 2015, prompting concerns about the potential loss of the small resident population (perhaps 7-10 lynx) documented there in the mid-1980s and again recently from 2002 to 2010. However, whether this absence indicates the extirpation of a previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. A single lynx was verified in the Garnet Range in February 2016, indicating that natural recolonization of the area is possible; however, no other detections of that lynx or other lynx have been verified since then, and there currently remains no evidence of lynx residency in this mountain range (Lieberg 2017, *pers. comm.*). Lynx in northwestern Montana (and northern Idaho) likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia. The extent to which lynx persistence in this area relies on immigration from Canada is unknown, and trapping harvest data suggest declining immigration after the mid-1980s (McKelvey *et al.* 2000a, p. 225; Squires *in* Lynx SSA Team 2016a, p. 20). In southwest Montana, few lynx and no recent evidence of reproduction have been documented in the Montana portion of the GYA where, as with the northwestern Wyoming part of the GYA (discussed above), uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016a, p. 57). As elsewhere in the West, recent research and habitat assessments suggest that habitats capable of supporting resident lynx in Montana are, and historically were, naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought when the DPS was listed (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016a, p. 12).

In Washington, research and monitoring conducted since the 2003 remand has continued to document a resident lynx population in the Okanogan region of the eastern Cascade Mountains in the north-central part of the state (von Kienast 2003, entire; Maletzke 2004, entire; Koehler *et al.* 2008, entire; Maletzke *et al.* 2008, entire; Maletzke *in* Lynx SSA 2016, pp. 21-22). Since at least 1985, this is the only area of the state with evidence of a resident breeding population (Koehler and Maletzke 2006, p. 4; Koehler *et al.* 2008, p. 1518; ILBT 2013, p. 58; Maletzke *in* Lynx SSA 2016, p. 21), although the Kettle Mountains in the northeastern part of the state are thought to have historically supported a small breeding population (possibly 10-20 resident lynx), and lynx are detected there occasionally (Stinson 2001, pp. 13–14; Koehler *et al.* 2008, p. 1523; USFWS 2008a, p. 2). Multiple large wildfires in this area over the last 25 years have burned about 34-37 percent of the Okanogan Lynx Management Zone (LMZ), resulting in a more than doubling of estimated female lynx home range size and a commensurate decline in the LMZ's potential lynx carrying capacity (Lewis 2016, pp. 4, 6; Maletzke *in* Lynx SSA 2016, p. 21). Although these areas should regenerate into lynx and hare habitat, it may take 35-40 years (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire impacts could further diminish habitat availability and the likelihood that the lynx population will persist (Lynx SSA Team 2016a, p. 44; see also sections 3.4, 4.2.4, and 5.2.4).

In summary, although uncertainty remains regarding the historical distribution of resident lynx in the DPS and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population declines in the contiguous United States from historical conditions until the DPS was listed have been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016a, p. 11). New information summarized above indicates that there are currently many more lynx in Maine and Colorado than likely occurred historically, and many more in those places and in Minnesota than was suspected when the DPS was listed. Likewise, resident lynx and some reproduction have also been documented recently in northern New Hampshire, where lynx were previously thought to have been extirpated, and in northern Vermont, which previously lacked evidence of historical lynx residency. Neither of these areas was occupied by lynx when the DPS was listed, and the expanding population in northern Maine was likely the source of lynx recolonizing northern New Hampshire and colonizing northern Vermont. Conversely, there are naturally fewer lynx and a more limited distribution of suitable habitats in most of the western United States than was previously thought (68 FR 40085, 40091-40092; ILBT 2013, p. 23), and lynx numbers in Washington have likely declined (perhaps temporarily) in response to extensive wildfire impacts to habitats over the past several decades. The geographic units evaluated in this SSA include all areas in the contiguous United States with strong historical or recent evidence of resident lynx populations. Detailed assessments of the current status and future viability of resident lynx populations and habitats in these areas are presented in chapters 4 and 5 below.

Chapter 3: Factors Influencing Viability of the DPS

In this chapter we discuss factors thought to influence the historical and current distribution and status of lynx populations in the contiguous United States, how these factors would likely

influence the future viability of the DPS, and we describe the cause-and-effects pathways of impacts associated with particular factors. We focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in Federal land management plans when the DPS was listed) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68-78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS.

3.1 Regulatory Mechanisms

A number of activities with the potential to affect lynx habitat suitability, productivity, mortality, and movements via habitat loss or fragmentation, creation of barriers, or that otherwise alter the vegetation mosaics and prey abundances maintained historically by natural disturbance processes may occur in lynx habitats regardless of land ownership and management. The extent to which regulations guide such activities to avoid, reduce, or mitigate impacts to lynx influences the current and future likelihoods that those habitats will provide the ecological requirements to support resident lynx populations. As described in more detail below, the lynx DPS was listed as threatened because of the lack of specific conservation direction and associated regulations on some Federal lands. At that time, the available information indicated that most lynx habitat in the DPS occurred on Federal lands, predominantly in the western United States (65 FR 16061). Since then, research and monitoring have revealed that non-Federal lands contribute more to the conservation of the DPS than was known at the time of listing, particularly in the Northern Maine and Northeastern Minnesota geographic areas. Therefore, in the following sections we describe and compare the Federal regulatory environment for lynx in the DPS at the time of listing and currently, and we describe other regulatory mechanisms as they pertain to lynx on private as well as State and Tribal lands.

3.1.1 Federal Regulatory Mechanisms

Since it was listed in 2000, the DPS has been protected by the ESA's prohibition on take (under section 9), which applies to lynx wherever they occur in the DPS, regardless of land ownership. The DPS has also been protected since listing by section 7 of the ESA, which requires Federal agencies to use their authorities to conserve listed species and to consult with the Service for any actions they implement, fund, or permit (i.e., for which a "Federal nexus" exists) and which may affect lynx or lynx habitats within the DPS, again regardless of land ownership. Additionally, section 4 of the ESA requires that critical habitat, defined as the specific geographic areas containing the physical and biological features essential for the conservation of a listed species and that may require special management and protection, be designated for listed species, and section 7 prohibits the destruction or adverse modification of such designated habitats. Critical habitat was designated for the lynx DPS in 2007 and was revised in 2009 and 2014; in accordance with a September, 2016 court order (U.S. District Court MT 2016, entire), it may be revised again in the future. Section 4 of the ESA requires recovery planning for listed species; a

recovery plan for the lynx DPS has not yet been completed, but part of the purpose of this SSA is to inform near-term recovery planning direction.

Federal lands make up approximately 64 percent of the lands encompassed by the 6 geographic units evaluated in this SSA. Of those Federal lands, roughly 87 percent is managed by the U.S. Forest Service (USFS), 11 percent by the National Park Service (NPS), and 2 percent by the Bureau of Land Management (BLM). The amount of Federal land varies by unit, ranging from 1 percent in the Northern Maine Unit to over 97 percent in the GYA Unit (see table 2 and Chapter 4 for ownership in each geographic unit). Federal lands management is guided by a number of statutes and associated regulations, policies, standards, guidelines, and best management practices (BMPs) applied by managing agencies to meet legislative mandates and achieve agency missions (for a summary of relevant Acts and associated regulations and guidance, see USFWS 2014, pp. 24-34). Many of these regulatory mechanisms provide some benefits to lynx and protect lynx habitats. For example, the conservation priority in the management of NPS lands in accordance with the National Park Service Organic Act (16 USC 1 *et seq*. as amended), the National Parks and Recreation Act (Public Law 95-625), and the Wilderness Act (16 USC 1131-1136, 78 Stat. 890) likely provides an adequate regulatory framework for the conservation of lynx populations and habitats in the NPS units in which they occur (USFWS 2014, pp. 28-29, 31-33). However, it was the absence of specific management direction and conservation measures for lynx and lynx habitats in USFS and BLM land management plans that led the Service to conclude that the regulatory mechanisms in those plans at the time of listing were inadequate to ensure the conservation of the DPS. Therefore, the evaluation below focuses on the efforts of USFS and BLM, in collaboration with the Service, to address the regulatory inadequacy for which the DPS was listed.

The Service designated lynx in the contiguous United States as a DPS and listed it as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx populations and potential lynx habitats (broad forest vegetation classes defined as “lynx forest types” [65 FR 16071]) in the contiguous United States occurred on Federal (USFS, NPS, and BLM) lands in the western states, and that the plans that guided management of those lands (particularly USFS and BLM lands) included “...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species” (65 FR 16052, 16082). At that time, the Service found that USFS and BLM management plans did not adequately address risks to lynx and, as identified in the LCAS (Ruediger *et al.* 2000, pp. 2-1 through 6-3), those plans allowed actions that cumulatively could result in significant detrimental effects to lynx in the contiguous United States. As a result, the Service concluded in the final rule that the lack of Federal land management plan guidance for the conservation of lynx and the potential for those plans to allow or direct actions that could adversely affect lynx constituted a significant threat to the DPS (68 FR 40096).

In 1998, in anticipation of the DPS’s listing under the ESA, regional and state directors of the Service, USFS, BLM, and NPS approved preparation of the interagency LCAS to provide a

consistent and effective approach to conserve lynx and to assist with section 7 consultation on Federal lands. An interagency Steering Committee selected a Science Team to assemble the best available scientific information on lynx and appointed the ILBT to prepare a lynx conservation strategy applicable to Federal land management in the contiguous United States (USFWS 2014, p. 15). The first edition of the LCAS was completed in January, 2000 and revised in August, 2000 (Ruediger *et al.* 2000, entire). The Steering Committee subsequently issued several amendments and clarifications, and the most recent revision of the LCAS was completed in August, 2013 (ILBT 2013, entire). The LCAS initially identified and evaluated 17 risk factors (e.g., timber and fire management, recreation, roads, livestock grazing, trapping, etc.) thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements and that may be addressed under programs, practices, and activities within the authority and jurisdiction of Federal land management agencies. These risk factors included programs or practices with the potential to result in habitat conversion, habitat fragmentation, or obstruction to lynx movement; roads or winter recreation trails that may facilitate access to historical lynx habitat by competitors; and fire suppression, which changes the vegetation mosaic maintained by natural disturbance processes. The risks identified in the 2000 LCAS were based on potential effects to lynx habitats and to individual lynx, lynx populations, or both; therefore, not all of the risks initially identified in the LCAS were thought to threaten lynx populations in the DPS (68 FR 40096). In the 2013 revised LCAS, risk factors were redefined as "Anthropogenic Influences on Lynx and Lynx Habitat," and grouped into 2 tiers based on the potential magnitude of effects (ILBT 2013, pp. 1, 68). First tier influences (climate change, vegetation management, wildland fire management, and habitat fragmentation - discussed in the remainder of this chapter) are those with potential to negatively affect lynx populations and habitats, while second tier influences are those that may affect individual lynx but are not expected to substantially impact populations or habitats (ILBT 2013, pp. 68-85).

In addition to identifying risks, the LCAS also directed Federal agencies to map potential lynx habitat and identify lynx analysis units (LAUs) to evaluate potential impacts of management actions on lynx and snowshoe hare habitats. Finally, the LCAS developed recommended conservation measures, standards, and guidelines to be applied to lynx habitats on Federal lands that were designed to mimic historical conditions and landscape-scale disturbance patterns and to maintain or improve lynx and hare habitats at both local (project-level) and landscape scales (USFWS 2014, p. 16). After its initial completion in 2000, USFS and BLM managers within the range of the DPS agreed to implement the standards and guidelines identified in the LCAS until management plans could be formally amended to specifically address lynx conservation. In 2000, the Service, USFS, and BLM developed and adopted Canada Lynx Conservation Agreements (CAs; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire) in which the BLM and USFS agreed to coordinate assessment and planning efforts with the Service to assure a comprehensive approach to lynx conservation and to use the LCAS, supporting science, and locally specific information as the basis for the approach and to streamline consultation under section 7 of the ESA. The USFS further committed to deferring any actions not involving third parties that would adversely affect lynx until such time as the Forest Plans were amended or revised to adequately conserve lynx (USFS and USFWS 2000, p. 8; 68 FR 40083).

Concurrent with development of the LCAS and interagency CAs, the USFS and BLM in 1999 completed the *Biological Assessment* (BA) *of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx* (USFS and BLM 1999, entire). The BA identified and evaluated the potential effects on lynx of implementation of 57 USFS Land and Resource Management Plans and 56 BLM Land Use Plans throughout the 14 states in which the lynx DPS was proposed for listing. The BA concluded that the potential for adverse effects to lynx existed on each administrative unit in each geographic area and that, cumulatively, implementation of the existing plans was likely to adversely affect the DPS. It recommended that all of the plans be amended or revised to incorporate conservation measures to reduce or eliminate adverse effects to lynx (USFS and BLM 1999, p. 14). In its 2000 biological opinion on the BA, the Service evaluated the USFS and BLM plans in conjunction with the CAs described above (USFWS 2000, p. 15). The Service concluded that implementation of the existing plans in accordance with the CAs until plans could be formally amended or revised was not likely to jeopardize the DPS, but that amendments or revisions to those plans were needed to further reduce or avoid the potential for adverse effects to lynx (USFWS 2000, pp. 48-50).

In the 2003 remanded rule, the Service similarly determined that adherence to the CAs, the biological opinion, and the LCAS in assessing the impacts of Federal actions on lynx alleviated the potentially-adverse effects of Federal land management activities on lynx, but that amendment of USFS and BLM land management plans to conserve lynx would be the strongest mechanism to ensure long-term conservation of lynx and lynx habitat on Federal lands (68 FR 40096-97). It concluded that although Federal, State, and Tribal regulations and plans had reduced threats to the DPS, the inadequacy of existing regulatory mechanisms still posed a moderate, albeit lower-level threat, and would continue to do so until Federal land management plans were specifically amended to address lynx conservation (68 FR 40097).

Since the 2003 remand, most Forest Service units with lynx forest types (actual and “potential” lynx habitats) have formally amended or revised their land management plans to incorporate the conservation measures, standards, and guidelines identified in the LCAS. Because these amended and revised plans apply to secondary areas and other potential lynx habitats (i.e., all mapped habitat in all LAUs), the USFS had applied the conservation measures to many areas outside the geographic units evaluated in this SSA, including many areas that lack evidence of lynx occupancy and some with no verified lynx records. From 2004-2006, forest plans for 7 national forests with potential lynx habitat in Maine, New Hampshire, Vermont, Michigan, Minnesota, and Wisconsin were revised to include recommendations from the LCAS and the CAs (Jackson 2015, p. 6; USFWS 2014, p. 33). In 2007, the USFS completed the Northern Rockies Lynx Management Direction (NRLMD), which formally amended management plans to include lynx conservation measures, standards, and guidelines for 18 national forests covering over 150,000 km^2 (57,915 mi^2) in Idaho, Montana, Wyoming and Utah, including over 72,000 km^2 (27,800 mi^2) of potential lynx habitat (USFS 2007, entire; USFWS 2014, pp. 16-19; 79 FR 54813; Jackson 2015 *in* Lynx SSA Team 2016b, Appendix 3, p. 11). In 2008, the USFS similarly completed the Southern Rockies Lynx Amendment (SRLA), which formally amended forest

plans covering about 59,000 km^2 (22,780 mi^2), including over 30,000 km^2 (11,583 mi^2) of mapped (potential) lynx habitat on 7 national forests or national forest complexes in western Colorado and southern Wyoming (USFS 2008a, entire; Jackson 2015 *in* Lynx SSA Team 2016b, Appendix 3, p. 11). The management direction adopted in the NRLMD and SRLA was developed in accordance with the National Forest Management Act of 1976 (16 USC 1600) and the regulations that implement the statute (36 CFR 219.22), which requires public review and comment as part of the decision making process. Among national forests within the geographic units evaluated in this SSA, only those in Washington (the Okanogan-Wenatchee and Colville national forests) have not formally amended or revised their land and resource management plans. However, the plan revision process has been initiated for both forests, and both continue to manage for lynx habitats in accordance with the LCAS and the CA. Overall, the USFS manages nearly 56 percent (72,927 km^2 [28,157 mi^2]) of the lands within the 6 geographic units evaluated in this SSA (see table 2, above), and all USFS lands are managed to support lynx conservation in accordance with formally revised or amended Forest Plans or binding conservation agreements with the Service.

The BLM manages a much smaller proportion of the lands within the SSA geographic units, nearly all of which occur in Colorado, Montana, and Wyoming. In Western Colorado (Unit 6), 10 BLM Field Offices (FOs; Colorado River Valley, Grand Junction, Gunnison, Kremmling, Little Snake, Royal Gorge, San Luis Valley, Tres Rios, Uncompahgre, and White River) contain 784 km^2 (303 mi^2) of potential lynx habitat. These BLM areas were subject to the 2000 interagency CA; however, that CA expired in 2004 (BLM and USFWS 2000, p. 8) and was not renewed. Since then, BLM Resource Management Plans (RMPs) have been revised for 5 of the 10 FOs (Colorado River Valley, Grand Junction, Kremmling, Little Snake, and Tres Rios). RMPs for the Gunnison, Royal Gorge, San Luis Valley, Uncompahgre, and White River FOs have not been revised and do not contain specific measures for the conservation of lynx; however, these areas constitute a very small proportion of lynx habitat this unit. In western Montana (Unit 3), BLM lands in the Garnet Resource Area include 405 km^2 (156 mi^2) of designated lynx critical habitat. In western Wyoming (Unit 5), 261 km^2 (101 mi^2) of BLM lands on the Kemmerer and Pinedale districts are also designated as lynx critical habitat. The RMP for the Garnet area was amended in 2004 to formally adopt the conservation measures of the LCAS (BLM 2004a, 2004b, entire), and the RMPs for the Pinedale and Kemmerer districts were revised in 2008 and 2010, respectively, to adopt conservation measures and BMPs for lynx (BLM 2008, pp. A18-10 - A18-16; BLM 2010, pp. A-9 - A-12). Overall, the BLM manages just over 1 percent (1,443 km^2 [557 mi^2]) of the lands within the 6 geographic units evaluated in this SSA (see table 2, above), most of which is actively managed to support lynx conservation.

The completion and implementation of the LCAS and its subsequent revisions, the interagency CAs, and the subsequent formal management plan revisions and amendments adopted under the NRLMD and SRLA all were undertaken to address the inadequacy of regulatory mechanisms on USFS and BLM lands for which the DPS was listed. Each incorporated the best available scientific information to develop goals, objectives, conservation measures, standards, and BMPs to guide USFS and BLM management activities at both project- and landscape-level scales to reduce or eliminate the potential for adverse effects to lynx or lynx habitats and thus

promote the conservation of the DPS (Ruediger *et al.* 2000, pp. 7-1 - 7-18; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire; USFS 2007, pp. 8-30, USFS 2008a, pp. 6-19, Attachment 1-1 - 1-9). Standards and guidelines developed and implemented in accordance with the NRLMD and the SRLA were designed to promote beneficial effects and limit potentially adverse effects of management activities (vegetation management [e.g., timber harvest, precommercial thinning], wildland fire and fuels management, grazing, recreation, road/access management, energy development, etc.) on important lynx habitats including winter snowshoe hare habitat (high-quality lynx foraging habitat), denning habitat, and linkage/connectivity corridors (USFS 2007, pp. 8-30, USFS 2008a, pp. 6-19, Attachment 1-1 - 1-9). The USFS concluded that the vegetation standards adopted in the NRLMD that limit the total amount and the rate at which lynx habitat can be converted to temporarily unsuitable habitat (stand-initiation seral stage following timber harvest) ensure that the agency's timber management program is beneficial to lynx and will provide sufficient lynx habitat through time at both LAU and landscape-level scales (USFS 2007, p. 35). In its biological opinion on the NRLMD, the Service concluded that its application "...would substantially reduce or eliminate adverse effects to lynx from Forest Service land management activities on at least 94 percent of this area (National Forest System lands in the Northern Rockies), and more likely nearer to 98 percent" (USFWS 2007, p. 76). Similarly, in its 2008 biological opinion on the SRLA, the Service concluded that vegetation management standards in the SRLA would prohibit treatments that could adversely affect essential components of lynx habitat on 95.5 percent of the mapped (potential) lynx habitat in the SRLA area (National Forest System lands in the Southern Rockies; USFWS 2008b, p. 52).

In summary, all USFS and most BLM lands with known or potential lynx habitat within the range of the DPS, including all SSA geographic units that encompass USFS and BLM lands, are currently managed in accordance with the specific conservation measures and considerations identified in the LCAS and implemented via the CAs or formally revised and amended management plans described above. These agreements and revised/amended plans constitute the regulatory framework and specific regulatory mechanisms adopted to conserve lynx habitats and populations on USFS and BLM lands that support or are potentially capable of supporting them. They represent the agencies' efforts, in collaboration with the Service, to address and ameliorate the singular threat for which the lynx DPS was listed under the ESA. Although formal effectiveness monitoring has not been completed, it is clear that implementation of the CAs and revised/amended plans, and the associated programmatic and project-specific consultations between BLM/USFS and the Service in accordance with section 7 of the ESA, have resulted in avoidance/minimization of impacts to important lynx and hare habitats on Federal lands and have reduced the likelihood that management activities on these lands may adversely affect lynx in the contiguous United States. Overall, Federal lands managed by the USFS, BLM, and NPS constitute nearly 64 percent 83,683 km^2 [32,310 mi^2]) of the area evaluated in this SSA, and all but a tiny fraction of these lands are actively managed for lynx conservation.

3.1.2 State Regulations and Tribal Management

Private, State, and Tribal lands make up the remaining 36 percent of the lands encompassed by the 6 geographic units evaluated in this SSA, accounting for almost 27 percent, almost 9 percent, and 1 percent of the total, respectively (table 2). The amount of private land varies by unit, ranging from 0.3 percent in the North-central Washington Unit to over 90 percent in the Northern Maine Unit. Likewise, State ownership varies from less than 1 percent in the GYA and Western Colorado units to 36 percent in the Northeastern Minnesota Unit. Tribal lands account for about 4 percent of the Northwestern Montana/Northeastern Idaho Unit and roughly 1 percent of the Northern Maine and Northeastern Minnesota units; there are no Tribal lands in the North-central Washington, GYA, or Western Colorado units. Private, State, and Tribal lands, combined, constitute 99 percent of the lands in the Northern Maine Geographic Unit and over half of those in the Northeastern Minnesota Unit. Because both of these units support larger resident lynx populations than was suspected when the DPS was listed and, therefore, may contribute more substantially to the conservation of the DPS than was understood at the time of listing, we must evaluate the regulatory mechanisms that pertain to lynx on these lands (Lynx SSA Team 2016a, p. 54). Although private, State, and Tribal lands constitute much smaller proportions of the other 4 (western) geographic units (from about 3 percent to 16 percent, combined), important lynx habitats occur on some of those lands, and regulatory mechanisms may influence their contributions to the conservation and persistence of DPS populations or parts of them. Therefore, in this section, we summarize the relevant regulatory frameworks and mechanisms that may affect lynx on private, State, and Tribal lands within the 6 geographic units of the DPS, but with a focus on those units with the greatest proportions of these lands and on activities on these lands with the greatest potential to impact lynx.

State Wildlife Management Regulations - The following information is derived largely from the Service's 2014 Incremental Effects Memorandum prepared in support of the revised designation of critical habitat for the lynx DPS (USFWS 2014, pp. 35-38) and updated as warranted by new information. State furbearer and other wildlife management regulations benefit lynx populations in the states where they occur. In addition to State and private lands, State wildlife regulations govern hunting and trapping activities on many Federal lands where those activities are permitted. Most states within the range of the lynx prohibited trapping and hunting of lynx prior to the Service's1998 proposal to list the DPS under the ESA, and those activities were prohibited in all states by the time the DPS was listed in 2000. All states within the lynx DPS range that allow legal bobcat harvest (1) manage in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Export Program for Appendix II Furbearer Species (USFWS 2014, pp. 25-26), (2) have distributed information to bobcat trappers and hunters on how to avoid incidental take of lynx, and (3) report all known incidental take of lynx associated with bobcat harvest to the Service's Division of Management Authority to assure that take does not exceed the amount permitted under the intra-agency section 7 consultation for the CITES Export Program (USFWS 2001, entire). Most states have also adopted special regulations in areas where lynx occur to minimize the potential for incidental take (including injury) of lynx during legal trapping of other furbearers. These efforts benefit lynx and are expected to do so in the future with continued implementation and

enforcement. Most reported incidentally-trapped lynx are released unharmed (see below), and there is no evidence that incidental trapping has had population-level impacts on lynx in the DPS range.

Unit 1: Northern Maine - In 1967, a bounty on lynx in Maine was repealed, and lynx were given complete protection from trapping and hunting. In Wildlife Management Districts where lynx may occur, the Maine Department of Inland Fisheries and Wildlife (MDIFW) has adopted special trapping regulations intended to minimize the incidental capture, injury, and death of lynx. These restrictions have varied over the past two decades, becoming mored restrictive with time following a consent decree in 2008. Some of the requirements developed over time include specification of trap sizes and sets that may be used to legally harvest other furbearers and that are intended to minimize the likelihood of incidentally trapping lynx[5] (MDIFW 2016a, pp. 8, 13). MDIFW has also prohibited the use of visual baits and visual attractants and reqires mandatory reporting of incidental lynx captures. MDIFW also adopted and made available for download on its web page the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*, modified it to be more specific to Maine, and updated it in 2015 (MDIFW 2015b, entire). MDIFW also set-up an incidental lynx capture hotline and has staff on stand-by to help immobilize, evaluate, collect tissue and/or hair samples, and release, if appropriate, any lynx reported to the hotline. From 2000 to 2016, this program has resulted in the release of 106 lynx that were reported incidentally trapped in northern Maine; during this time, 12 lynx died from traps or being illegally shot while in traps (MDIFW 2014, p. 75; MDIFW 2016b, pp. 5-10).

After preparing a habitat conservation plan (Incidental Take Plan), the MDIFW in 2014 obtained an incidental take permit from the Service for lynx trapped incidental to predator management and animal damage control activities, and the recreational furbearer trapping program in Maine. The permit allows incidental trapping of 195 lynx over a 15-year period, including 3 mortalities. After 2 lynx were killed in leaning-pole trap sets in 2014, MDIFW imposed additional trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx, as required by the permit (also see Other Factors in section 4.2.1 below). In addition to prohibiting the type of leaning-pole sets that resulted in the 2 mortalities, the regulations now require exclusion devices on most killer-type traps and multiple swivels on chains, and they prohibit the use of drag sets on foothold traps.

The MDIFW also is responsible for implementing the Maine Endangered Species Act[6] (MDIFW 2009, p. 9). Although the lynx is not State-listed as threatened or endangered because its population is believed to exceed the State's listing threshold, it is considered a species of special concern (MDIFW 2011, p 2). The MDIFW works collaboratively with the Service to conduct research and monitor lynx populations and habitats, and it recommends voluntary forest management activities to promote a sustainable supply of large, connected, and widely-distributed blocks of dense, young spruce-fir stands and to conserve large blocks of unfragmented forestland in northern and western Maine (MDIFW 2011, p. 3).

[5] http://www.maine.gov/ifw/hunting_trapping/trapping/avoid_lynx.htm, last accessed 8.08.2016.
[6] http://www.mainelegislature.org/legis/statutes/12/title12sec12803.html.

Unit 2: Northeastern Minnesota - Although lynx were unprotected and had a bounty placed on them in Minnesota prior to 1965, lynx trapping and hunting have been prohibited in Minnesota since 1984 (65 FR 16077; Moen *in* Lynx SSA Team 2016a, p. 19). Overlapping the Northeastern Minnesota SSA unit, the Minnesota Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ) for which it has promulgated and enforces special trapping regulations for other furbearers in lynx habitat (MNDNR 2016a, p. 53). The MNDNR has modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (MNDNR 2016a, pp. 53-55). The MNDNR also distributed to trappers the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*. In response to a Federal court order, MDNR developed an incidental take plan designed to minimize the potential for lynx to be incidentally trapped during other legal furbearer trapping; the plan is currently under review by the Service. Like Maine, Minnesota has a State Endangered Species Statute (84.0895) which requires the MNDNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern (State of Minnesota 2016, entire). The Statute also authorizes the MNDNR to adopt rules that regulate treatment of species designated as endangered and threatened. Also like Maine, however, Minnesota has not designated lynx as threatened or endangered under the statute. Instead it has designated the lynx a species of special concern, a designation for species that are extremely uncommon, have unique or highly specific habitat requirements, or occur on the periphery of their range in Minnesota and, therefore, deserve careful monitoring (MNDNR 2013, pp. 1-2). Thus, the MNDNR coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats.

Unit 3: Northwestern Montana/Northeastern Idaho - Lynx are designated as a species of greatest conservation need (S3; "potentially at risk") by the State of Montana (MTFWP 2015, pp. 12, 435) and were previously considered a species of greatest conservation need (S1) by the State of Idaho (ILBT 2013, p. 57). However, in its recently revised State Wildlife Action Plan, Idaho did not retain that designation for lynx because of the lack of evidence of a persistent lynx presence in the state (IDFG 2017a, p. 4). The harvest of lynx was prohibited in Idaho and Montana beginning in 1996 and 1999, respectively. Both States participate in the CITES Export Program for bobcats, and both have promulgated and enforce special regulations for the legal trapping of other furbearers in areas occupied by lynx. In its trapping regulations, Idaho Fish and Game (IDFG) provides information on how to distinguish between bobcats and lynx and provides guidelines to reduce injury and minimize non-target catches, including lynx (IDFG 2017b, pp. 36-37). Guidelines recommend (1) a minimum 8-pound pan tension on foothold traps set for wolves, (2) specific trap types and sets for other furbearers, and (3) bait and habitat considerations when making sets. Trappers are also required to contact IDFG or local sheriff's offices to assist with the safe release of incidentally trapped lynx. Three of 4 lynx incidentally trapped in Idaho recently were released unharmed; the other was illegally shot (IDFG 2017a, p. 3). To minimize and track the incidental capture of lynx, Montana Fish, Wildlife, and Parks

(MTFWP) has promulgated an evolving set of trapping regulations and reporting requirements since the DPS was listed (MTFWP 2016, pp. 7-10), including significant changes in 2008 that reduced the reported rate of incidental lynx captures from 1.6 per year in 2000-2007 to 0.4/year in 2008-2015 (MTFWP 2016, p. 5). In 2015, the Federal District Court of Montana approved a settlement agreement reached between the State of Montana and conservation groups aimed at protecting lynx from trapping. The case is now dismissed in accordance with the agreement, under which Montana has implemented a set of restrictions on trapping in lynx habitat. Currently, these regulations identify designated lynx protection zones (LPZs) and define acceptable trapping methods for public lands within them, which (1) prohibit the use of lethal (non-relaxing) snares for bobcats, (2) specifies the types of sets and baits or attractants that may be used for marten, fisher, and other furbearers where lynx occur, (3) requires a minimum 10-pound pan tension on foothold traps set for wolves, and (4) requires that any incidentally trapped lynx must be released unharmed if possible and reported to MTFWP (MTFWP 2016, pp. 7-10).

Unit 4: North-central Washington - Lynx harvest has been prohibited in Washington since 1991, and the lynx was listed as a State threatened species in 1993 and uplisted to endangered in 2016 (Lewis 2016, pp. *iii*, 1; WAFWC 2016, p. 3). Under the State's Endangered Species Program, the Washington Department of Fish and Wildlife (WADFW) developed a Lynx Recovery Plan[7] and a Status Report[8], and it prepares annual reports to update population and habitat information for the species. The WADFW also coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats. Additionally, the use of body-gripping traps (foothold, conibear, snares, etc.) for trapping other furbearers is prohibited in Washington (except for damage control or nuisance wildlife, which requires special permits). This avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

Unit 5: GYA (Southwestern Montana and Northwestern Wyoming) - See Unit 3, above, for summary of Montana's special trapping regulations to minimize incidental take of lynx, which apply to the northern part of this unit. Lynx in Wyoming are classified as nongame wildlife, a Species of Greatest Conservation Need, and a Protected Animal by Wyoming State Statute. A classification of "State Protected" status prohibits trapping or any intentional take in the state, and lynx in Wyoming were offered full protection from trapping and hunting beginning in 1973 (ILBT 2013, p. 57). The Wyoming Game and Fish Department (WGFD) also participates in the CITES Export Program for bobcats.

Unit 6: Western Colorado - Lynx harvest has been prohibited in Colorado since 1970 and the lynx was listed as endangered in the State in 1973. Colorado participates in the CITES Export Program for bobcats, provides information to trappers and hunters on how to distinguish between lynx and bobcats, and requires immediate release of uninjured incidentally trapped lynx as well as reporting of any (uninjured, injured, or killed) incidentally trapped lynx (CPW 2015, pp. 6-7). Colorado law prohibits the use of foothold or conibear traps and snares for

[7] http://wdfw.wa.gov/publications/00394/.
[8] http://wdfw.wa.gov/publications/01521/.

trapping, which avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

State Forest Management Regulations - Timber harvest and other forest management activities on State and private lands are governed by State regulations. Because these activities have the potential for beneficial, benign, or adverse impacts to lynx habitat depending on methods, implementation, and conservation measures, State forestry regulations may influence lynx populations, particularly where substantial amounts of lynx habitat occur on State and private lands. Below, we provide an overview of the forest management regulations in the SSA geographic units and briefly discuss their potential influences on lynx habitat. Additional details on the current and likely future influences of these regulations on lynx populations are provided below in chapters 4 and 5, particularly for the Maine and Minnesota units, where State and private lands constitute the majority of lynx habitats.

Unit 1: Northern Maine - State and private lands constitute 7 percent and 90 percent, respectively, of this SSA unit, with the vast majority of private lands managed for commercial timber production. As described above in section 2.3.2.2 and in more detail below in sections 4.2.1 and 5.2.1, the current abundance of lynx in northern Maine is attributable to the landscape-scale clear-cutting that occurred on private timber lands in the 1970s and 1980s in response to an extensive spruce budworm outbreak, which resulted in the recent unnaturally large amount of young (15 to 35 years post-harvest) regenerating forest in prime hare (lynx foraging) habitat condition. The amount and distribution of this post-clear-cut high-quality hare habitat likely peaked in the late 1990s to early 2000s, when 20-25 percent of the forest in Maine was in an early regeneration stage. The amount of young, regenerating forest at that time was 3 to 8 times higher than typical historical conditions under the natural disturbance regime, when only 3 to 7 percent of stands were likely in such condition at any given time (68 FR 40094). Current timber harvest and management on State and private lands in Maine are governed by the Maine Forest Practices Act of 1989 and administered by the Maine Forest Service within the Department of Agriculture, Conservation & Forestry to regulate, among other things, the size, arrangement, regeneration, and management of clearcuts (MEDACF 2014, pp. 42-45). Under the Act, small (up to 101 ha [250 ac]) clear-cuts are still permitted but require special permits and review and have, therefore, been replaced by various forms of partial harvest techniques; many of which are unlikely to maintain the current unnaturally high amount and distribution of high-quality hare and lynx habitat. The consequences of this large-scale shift in forest management on Maine's current lynx population, which is likely much larger than was possible under the natural historical disturbance regime, and on future conditions for lynx in this unit are discussed below in sections 4.2.1 and 5.2.1, respectively, along with other programs and factors that may influence private lands forest management in this unit.

In Maine, most private lands lack long-term management agreements to assure lynx conservation. However, in 2006 and 2007, the Natural Resource Conservation Service (NRCS) provided funds to Maine for a pilot Healthy Forest Reserve Program (HFRP) specifically to manage for Canada lynx and American marten. Under this program, 4 landowners have developed and implemented lynx management plans covering about 652 km^2 (252 mi^2; 2.3

percent of Unit 1). All 4 landowners completed lynx plans using guidelines in the Service's *Canada lynx management guidelines for Maine* (McCollough 2007, entire). NRCS contracts with the landowners last for 10 years and these contracts expired in 2016 and 2017. The HFRP described an opportunity for enrollees to apply for Safe Harbor Agreements when their contracts expired, although none have yet indicated an interest in doing so. Management plans were written for a 70-year period; therefore, some landowners may continue voluntary lynx management activities. Many private landowners in Maine are enrolled in forest certification programs; the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Both programs require landowners to protect endangered species and their habitats. Maine has more than 40,500 km^2 (15,625 mi^2) of certified forestland; more than any other state[9]. It is uncertain how certified landowners address lynx management. About 10,117 km^2 (3,906 mi^2; 35 percent of Unit 1) of private lands in northern Maine are under "working woodland" conservation easements[10]; although these covenants do not require specific management practices or outcomes beyond sustainable forestry, they do ensure that conversions to other land uses will never occur (MDIFW 2017, p. 2). In the past Maine private forest landowners have expressed interest in long-term commitments to lynx management plans, but to our knowledge, there are no private landowners in Maine who have committed to long-term or permanent protection and creation of lynx habitat according to the Service's lynx management guidelines or the LCAS.

State lands include Baxter State Park (809 km^2 [312 mi^2; about 3 percent of Unit 1]) and the various lots owned and managed by the Maine Bureau of Parks and Lands (MBPL). Most of Baxter State Park is managed as wilderness area, and lynx sightings in the Park are rare, probably because most of the park is mature forest that does not support high hare densities. MBPL integrated resource policy requires that it promote the conservation of Federally-listed species. To our knowledge, with one exception, MBPL has not developed any lynx-specific management plans. However, the mitigation for the MDIFW's incidental take permit for trapping requires the maintenance, enhancement and creation of lynx habitat on about 28 percent of the MBPL's 89-km^2 (34-mi^2) Seboomook habitat management unit during a 15-year period, with those habitats likely available to lynx beyond that time.

Unit 2: Northeastern Minnesota - State and private lands constitute about 36 percent and 16 percent, respectively, of this SSA unit. The MNDNR Division of Forestry regulates timber harvest and management on State and private lands. Under the Sustainable Forest Resources Act of 1995 (revised most recently in 2014 [MNFRC 2014, p. 1]), the Minnesota Forest Resources Council (MNFRC) has developed voluntary guidelines for site-level timber harvesting and forest management (MNFRC 2012, p. 1) that are intended for private and State landowners and include some general recommendations for wildlife including lynx. However, because they are voluntary, the extent to which these guidelines benefit lynx is uncertain (see sections 4.2.2 and 5.2.2 below).

[9] http://nsrcforest.org/sites/default/files/uploads/seymoursherwood13full.pdf, accessed 7.27.2017
[10] http://web.colby.edu/stateofmaine2012/state-of-large-landscape-conservation-in-maine/, accessed 8.18.2016.

Unit 3: Northwestern Montana/Northeastern Idaho - State and private lands constitute about 4 percent and 8 percent, respectively, of this SSA unit and almost all are in the Montana portion of the unit. The Montana Department of Natural Resources and Conservation (MTDNRC) administers several laws pertaining to forest practices on State and private lands. These laws are intended to protect streamside management zones, reduce fire hazards, and provide BMPs to minimize non-point source water pollution[11]. Although these laws may provide indirect benefits to lynx and other wildlife, they do not include specific measures to conserve or avoid impacts to lynx habitats. However, the MTDNRC and the Service collaborated on a multi-species habitat conservation plan (HCP) for forested State Trust lands that includes a Lynx Conservation Strategy to minimize impacts of forest management activities on lynx and describes conservation commitments that are based on recent information from lynx research in Montana (USFWS 2104, pp. 22-23; 79 FR 54835-54837). This HCP covers about 64 percent of the State lands in this SSA unit, regulates activities primarily associated with commercial forest management to conserve lynx foraging, denning, and connectivity habitats, and includes a 50-year commitment (79 FR 54835-54836). Additional details on this HCP and other programs for conserving lynx habitats on State and private lands in this unit are provided in section 4.2.3 below.

Unit 4: North-central Washington - State and private lands constitute about 8 percent and 0.3 percent, respectively, of this SSA unit and most are State Trust lands in the Loomis State Forest, which accounts for all 426 km^2 (164 mi^2) of State lands in this unit. The Washington Department of Natural Resources (WADNR) administers rules guiding forest practices, such as timber harvests and road building, on State, private, and tribal forests in Washington. The Forest Practices Board, an independent State agency, adopts forest practices rules to protect water quality, fish habitat, other public resources and guide DNR's permitting process for timber harvests and other forest practices statewide. The WADNR developed a Lynx Habitat Management Plan (LHMP) for WDNR-managed lands distributed throughout north-central and northeastern Washington in areas delineated as Lynx Management Zones in the Washington State Lynx Recovery Plan (Stinson 2001, entire; Washington DNR 2006, entire). The WADNR LHMP guides timber harvest and other vegetation management on these lands, including the part of the Loomis State Forest that occurs in this unit, with the goal of creating and preserving quality lynx habitat through its forest management activities. Additional information on the LHMP is provided in sections 4.2.4 and 5.2.4 below.

Unit 5: GYA - State and private lands constitute about 0.3 percent and just over 2 percent, respectively, of this SSA unit and, combined, likely have little influence on lynx population persistence. Forestry regulations for the Montana portion of this unit are described above. In the Wyoming portion, the Wyoming State Forestry Division is responsible for the management of forested trust land across the state, including timber management and harvest, for long term forest health and productivity. Although the Division's programs may provide some indirect benefits to lynx, they do not include species- or habitat-specific regulations or conservation measures.

[11] http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices, accessed 7.18.2016.

Unit 6: Western Colorado - State and private lands constitute about 0.6 percent and over 9 percent, respectively, of this SSA unit. The Colorado Department of Natural Resources and the State Division of Forestry oversee forest management activities on State and private lands in Colorado.

Tribal Management: Tribal lands contribute 1,408 km^2 (544 mi^2; just over 1 percent) of lynx habitat to the geographic units evaluated in this SSA. This includes lands of the Passamaquoddy Tribe and the Penobscot Indian Nation in Maine (248 km^2 [96 mi^2] in Unit 1), Grand Portage Band of Lake Superior Chippewa in Minnesota (202 km^2 [78 mi^2] in Unit 2), and the Confederated Salish and Kootenai Tribes of the Flathead Nation - Flathead Reservation in Montana (958 km^2 [370 mi^2] in Unit 3). Tribal management of these lands is expected to benefit lynx and lynx habitats. No tribal lands occur within SSA units 4, 5, or 6.

Unit 1: Northern Maine - Tribal lands represent less than 1 percent of this unit. The Passamaquoddy Tribe has lands enrolled in the Healthy Forest Reserve Program, described above. The Passamaquoddy Tribe's stated environmental mission is "...to protect the environment and conserve natural resources within all Passamaquoddy lands, waters, and the air we share" (Passamaquoddy Tribe 2014, entire). That of the Penobscot Indian Nation Department of Natural Resources is "...to manage, develop and protect the Penobscot Nation's natural resources in a sustainable manner that protects and enhances the cultural integrity of the Tribe" (Penobscot Indian Nation 2014, entire). Hunting, trapping or possessing lynx are prohibited in accordance with the Penobscot Indian Nation Chapter VII Inland Fish and Game Regulations – Section 204 (Penobscot Indian Nation 2012, p. 15). Tribal lands of the Aroostook Band of Micmac Indians and Houlton Band of Maliseet Indians occur immediately adjacent to this unit and lynx are thought to occupy both areas occasionally.

Unit 2: Northeastern Minnesota - Tribal lands of the Grand Portage Indian Reservation and the Bois Forte Indian Reservation—Vermillion Lake District represent 1 percent of this SSA unit. The Grand Portage Band of Chippewa has been actively working on lynx conservation since 2004. In October 2007, the Band hosted an international conference on lynx research and conservation where more than 50 researchers from the United States and Canada presented results of research on lynx diet, habitat, and management. Additionally, on-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire).

Unit 3: Northwestern Montana/Northeastern Idaho - Tribal lands of the Confederated Salish and Kootenai Tribes of the Flathead Nation, Flathead Reservation represent nearly 4 percent of this SSA unit. The mission statement of the Tribes' Fish, Wildlife, Recreation and Conservation Division is "...to protect and enhance the fish, wildlife, and wildland resources of the Tribes for continued use by the generations of today and tomorrow" (Confederated Salish and Kootenai Tribes 2014a, entire). An objective of the Tribes' Tribal Wildlife Management Program Plan is to ". . . develop and implement habitat management guidelines for Canadian lynx in coordination

with the Forestry Department as specified in the Forest Management Plan'' (Confederated Salish and Kootenai Tribes. 2014b, p. 5). The Forest Management Plan states that ''Standards for lynx management and habitat protection are set forth in the Canada Lynx Conservation Assessment and Strategy. This strategy guides land management activity in lynx foraging and denning habitat. Lynx occurrence and populations will continue to be monitored on the Reservation'' (Confederated Salish and Kootenai Tribes 2000, p. 285).

In summary, a variety of State wildlife and forestry regulations and conservation efforts, along with Tribal resource management objectives, influence activities in lynx habitats across the range of the DPS. While many of these clearly benefit lynx habitats and likely contribute to the persistence of resident populations, uncertainty remains regarding the effectiveness of some regulations and voluntary programs or measures in maintaining or restoring lynx habitats. This may be especially important with regard to timber management regulations and programs on private lands, which constitute the majority of lands in the Northern Maine geographic unit and a substantial amount of the Northeastern Minnesota unit.

3.2 Climate Change

''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements (IPCC 2007, p. 78; IPCC 2014b, pp. 119-120). The term ''climate change'' thus refers to a change in climate that can be identified statistically by changes in the mean and/or variability of 1 or more measures of climate (e.g., temperature or precipitation) that persists for decades or longer, whether the change is a result of natural variability, human activity, or both (IPCC 2014a, p. 5). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation; IPCC 2007, pp. 8–14, 18–19; Melillo *et al*. 2014, p. 12).

In 2014, the International Panel on Climate Change (IPCC) released its Fifth Assessment Report (AR5), which represents the current scientific consensus on global and regional climate change and the best synthesis of scientific data available in this rapidly changing field. The AR5 largely reaffirms the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere (IPCC 2014a, entire). The report concludes that the strongest and most comprehensive evidence of the impacts of climate change is in natural systems, where many species have responded by shifting their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC 2014a, p. 4). It also concludes that projected climate change during and beyond the 21st Century will likely increase extinction risk for many terrestrial and freshwater species (IPCC 2014a, pp. 14–15).

Globally, annual average temperature increased by 0.61°C (1.1°F; range = -0.53° to +2.50°C [-0.95° to +4.5°F]) from 1850-1900 to 1986-2005 (IPCC 2014a, pp. 10-11). Greenhouse gas

emissions are increasing and tracking levels predicted by models for high emissions scenarios (e.g., RCP 8.5; Hartmann *et al*. 2013, p. 180, 187-189; Peters *et al.* 2013, entire; Friedlingstein *et al.* 2014, p. 709, 712; Fuss *et al.* 2014, p. 851). Analysis of paleoclimate data indicates 20th century warming is likely to have been the largest of any century within the last 1,000 years (Folland *et al.* 2001, pp. 99-101). These changes are predicted to continue and accelerate under future climate scenarios (Hall and Fagre 2003, fig. 7; Peters *et al*. 2013, entire, fig. 1). The IPCC projects that mean surface temperature will likely increase globally by 0.4° - 2.6°C (0.7° - 4.7°F) by mid-century and 0.3° - 4.8°C (0.5° - 8.6°F) by the end of this century relative to the 1986-2005 period (IPCC 2104b, p. 60). Rogelj *et al*. (2012, entire, table 1) concluded that the change in global mean surface temperature at equilibrium by 2100 has a greater than 95 percent probability of increasing more than 1.5°C (2.7°F), a 76 percent probability of increasing 2° - 4.5°C (3.6° - 8°F), and a 14 percent probability of exceeding 4.5°C (8°F).

In North America, climate history and projections from regional climate models corroborate global models, and indicate that both eastern and western North America, including all portions of the lynx DPS, have warmed in the last century and are likely to warm by 1° to 3°C (1.8° to 5.4°F) by the year 2050 (Christensen *et al*. 2007, p. 889; IPCC 2014a, pp. 23, 31; Romero-Lankao *et al*. 2014, pp. 1452-1454) and by 1.7° to 5.6°C (3° to 10°F) by the end of this century (Melillo *et al*. 2014, p. 8). The greatest increases in winter surface air temperatures in North American are projected in the interior of Canada, but large increases (in the range of 3.9°C [7°F]) are also expected in the northern contiguous United States by 2051 to 2060 (NOAA 2007[12], entire). To date, the observed and predicted increases in surface temperatures have been greater in the Northern Rocky Mountains and the Northeast (much of the lynx DPS) than elsewhere in the contiguous United States (Romero-Lankao *et al*. 2014, pp. 1453-1454; Lynx SSA Team 2016a, pp. 14-15). For example, in the Northern Rockies at Glacier National Park, mean summer temperatures increased 1.7°C (3.0°F) between 1910 and 1980, resulting in lower snowpack, earlier spring melt, and distributional shifts in vegetation (Hall and Fagre 2003, pp. 134–139; Fagre 2005, pp. 4–9). Observed impacts attributable to climate change that may affect lynx habitats and populations include upslope and northward shifts in species distributions across multiple taxa, decreases in snow cover and duration, and increased wildfire and insect activity in boreal and subarctic conifer forests of Canada and the western United States (Vaughan *et al*. 2013, pp. 358-360; Georgakakos *et al*. 2014, p. 72; Groffman *et al*. 2014, pp. 200-205; IPCC 2014a, p. 31; Joyce *et al*. 2014, pp. 176-179; Melillo *et al*. 2014, p. 17; Romero-Lankao *et al*. 2014, pp. 1456, 1458-1461).

When we listed the DPS in 2000, the Service determined there was no evidence that global warming was a threat to lynx (65 FR 16068-16069). In 2003, we concluded that the information available regarding the potential impact of climate change on lynx was speculative and did not demonstrate a threat to lynx (68 FR 40083, 40098). In the 2005 recovery outline, we acknowledged that continued climate warming was likely to negatively affect the boreal forest ecosystem for which lynx are highly adapted, eventually causing it to recede north and/or to higher, colder elevations, potentially resulting in a substantial future reduction or even

[12] https://www.gfdl.noaa.gov/wp-content/uploads/files/research/climate-change/gfdlhighlight_vol1n6.pdf last accessed 7.27.2017.

elimination of lynx habitats from the contiguous United States (USFWS 2005, pp. 11, 14). In the 2009 and 2014 revised critical habitat designations, the Service acknowledged that new science suggested that climate change may pose a significant risk to the future conservation of the lynx DPS (74 FR 8617, 8621; 79 FR 54811).

There is growing scientific evidence of accelerated athropogenically-influneced global climate warming during the 20th and early 21st centuries and little doubt among climatologists that this warming will continue and may increase in the future (Hansen *et al.* 2006, entire; IPCC 2014a, entire). Because the lynx is a cold-climate and snow-adapted habitat and prey specialist, there is general agreement that the species is vulnerable (highly sensitive, broadly exposed, and with limited adaptive capacity to respond favorably; therefore, predisposed to be adversely affected [IPCC 2014a, p. 5]) to climate warming and that the anticipated effects of continued warming will be adverse (not beneficial) for lynx, especially at the southern periphery of its range. Therefore, lynx biologists now identify climate change as the factor most likely to influence long-term resiliency of the DPS (Lynx SSA Team 2016a, pp. 14, 17, 19, 21-22, 35-47, 50, 53-57; ILBT 2013, pp. 43, 48, 53, 55, 63, 66, 69-71, 98).

Continued climate warming is expected to diminish boreal forest habitats and snow conditions at the southern edge of the range (all of the DPS range) that are, in some places, already patchily-distributed and perhaps only marginally capable of supporting resident lynx. Climate models project reductions in the extent of boreal forest habitats and snow conditions thought necessary to support lynx throughout the DPS, with both features predicted to migrate northward in latitude and to higher elevations (where possible; Sturm *et al.* 2001, pp. 342-342; Carroll 2007, pp. 1099-1102; Danby and Hik 2007, pp. 360-362; Gonzalez *et al.* 2007, entire; Gonzalez *et al.* 2010, pp. 761-766; McKelvey *et al*. 2011, entire; Johnston *et al*. 2012, pp. 8-11; ILBT 2013, p. 69; Koen *et al.* 2015. p. 528;). This would result in fewer, smaller, and more fragmented and isolated areas capable of supporting resident lynx and therefore smaller and more isolated lynx populations that would be more vulnerable to stochastic environmental and demographic events and genetic drift (Carroll 2007, pp. 1099–1100; Johnston *et al.* 2012, p. 11; 79 FR 54811; Schwartz 2017, pp. 4-5). Climate change has also been linked to increases in wildfire and forest insect activities in North America (Joyce *et al*. 2014, pp. 177-179; Romero-Lankao *et al*. 2014, pp. 1459-1461); two important components of boreal forest disturbance and, therefore, lynx habitat quality, quantity, and distribution. It also may affect other factors that could influence the future health of lynx populations in the DPS, such as hare/lynx cycles in Canada, disease transmission, and parasites.

Although projected climate warming is expected to reduce the future distribution and number of lynx in the DPS, there remains substantial uncertainty about the timing, rate, magnitude, and extent of potential impacts that may affect lynx populations in the DPS and how (and when) those populations may respond to increasing tempreatures and altered precipation patterns and disturbance regimes. Despite these uncertainties, specific effects of climate warming on lynx, hares, and their habitats in the DPS range that are occurring or can be reasonably anticipated include: 1) northward and upslope contraction of boreal spruce-fir forest types, 2) northward and upslope contraction of snow conditions believed to favor lynx over other terrestrial hare

predators, 3) reduced hare populations and densities, and 4) changes in the frequency, pattern, and intensity of forest disturbance events. Other potential effects of projected warming include: 5) reduced gene flow between Canadian and DPS lynx populations, 6) changes in the periodicity and amplitude of northern hare cycles, which could result in reduced lynx immigration to the DPS from Canada, and 7) increased or novel diseases and parasites. Each of these factors is discussed in more detail below.

Northward and Upslope Contraction of Boreal Spruce-fir Forest Types – Historically, boreal forest (lynx habitat) distribution in the contiguous United States has changed dramatically in response to changes in climatic conditions. It nearly disappeared from the Northeast 1,000 years ago during the interglacial warming period, then returned south into New England only in the past few centuries during the "Little Ice Age" (DeHayes *et al.* 2000, entire; Schauffler and Jacobson 2002, entire; also see 5.2.1). In the West during prehistorical periods of warmer climate, the alpine treeline ecotone (upper elevation of lynx boreal habitat) and deciduous-boreal forest ecotone (lower elevation of lynx boreal habitat) readily moved upslope in both the Northern and Southern Rockies (Legg and Baker 1980, pp. 331-332; Kearney and Luckman 1983, pp. 783-784). Boreal forest was likely continuous from the Canadian border south through the Southern Rockies of Colorado and northern New Mexico until the climate began warming and drying beginning about 15,000 years ago. That warming caused a northward and upslope retreat of the boreal zone to its current distribution, which has resulted in a naturally patchy distribution of boreal forest in the western United States that has remained relatively stable for the past 3,000 years (ILBT 2013, p. 50), with some patches largely isolated from more contiguous areas of boreal forest to the north.

Now, projected temperature increases and changes in precipitation patterns are expected to again shift the distribution of northern hemisphere ecosystems northward and up mountain slopes (McDonald and Brown 1992, pp. 411–412; Danby and Hik 2007, pp. 358–359; IPCC 2014a, pp. 3, 24-29; Groffman *et al*. 2014, p. 200). On a global or continental scale, there is general agreement that temperature is a primary determinant of treeline (Decker and Fink 2014, p. 122). Based on historical evidence, treeline is generally expected to migrate to higher elevations as temperatures warm, as permitted by local microsite conditions, although there may be a lag time in some mountain ranges (Smith *et al*. 2003, entire; Richardson and Friedland 2009, pp. 7-8, 15-16; Grafius *et al*. 2012, entire; Decker and Fink 2014, p. 67). McKenney *et al.* (2007, entire) predicted that the ranges of North American tree species will likely decrease, on average, by 12 percent and will shift northward by 700 km (435 mi) during this century. Several authors have also suggested that grasslands, aspen (*Populus* spp.) parklands, and temperate forest will expand northward, resulting in decreases in some areas that are currently boreal forest (Rizzo and Wiken 1992, p. 50; Starfield and Chapin 1996, entire; Rupp *et al.* 2000, entire; Galatowitsch *et al*. 2009, pp. 2015-2018), which could further fragment spruce-fir habitat (Iverson *et al.* 2008, p. 404; Tang and Beckage 2010, pp. 152-156; Rustad *et al.* 2012, p. 15; Simons-Legaard *et al.* 2016, p. 5). Thus, projected future warming is expected to cause another northward and upslope contraction of boreal forest in some parts of the contiguous United States (and in Canada; Groffman *et al*. 2014, p. 200), likely with negative

consequences for both lynx and snowshoe hare populations in the DPS and in southern Canada (Gonzalez *et al.* 2007, entire).

Some predicted changes to the boreal forest are already occurring, and much of the climate-induced change is occurring faster than originally predicted, suggesting rapid change as opposed to slow linear change (Soja *et al.* 2007, pp. 5-6; Settele *et al*. 2014, pp. 303-305). Globally, temperatures are increasing and snowfall is declining at the fastest rates in the high-latitude boreal forests of Canada and Eurasia (IPCC 2007, pp. 9, 52, 72), and climate models agree that winter warming across the circumboreal region will likely exceed 40 percent above the global mean winter warming (Soja *et al.* 2007, p. 4). Higher summer temperatures are thought to limit the distribution of boreal spruce-fir forests, which also are believed to be more sensitive to drought than other forests (Iverson and Prasad 2001, pp.192–196; Lenton *et al.* 2008, pp. 1788, 1791). In fact, over the past century, northward and upward (in elevation) biome shifts (the replacement at a location of one suite of species by another) in boreal ecosystems have been detected in numerous locations (Settele *et al*. 2014, pp. 278-279). Several studies (Joos *et al.* 2001, entire; Lucht *et al.* 2006, entire) suggest a temperature-increase threshold for boreal forest dieback of about 3°C (5.4°F), and some boreal forests are experiencing increases in tree mortality (Peng *et al.* 2011, entire). For example, widespread mortality and reduced growth in red spruce (*Picea rubens*; a component of lynx habitat in Unit 1) in the Northeastern United States in the 1960s to 1980s were believed to be linked to climate stress (McLaughlin *et al.* 1987, p. 501; Johnson *et al.* 1988, p. 5373).

Although increased precipitation is expected in the boreal region of Canada, particularly during the winter, it may be offset by increases in summer drought, heat stress, and evapotranspiration (Stocks *et al.* 1998, entire). Lienard *et al.* (2016, p. 7) conclude that spruce-fir forest types in New England, the Northern Great Plains, and higher elevations in the Rockies are vulnerable to drought-related stress from climate change during the next century. Nonetheless, Decker and Fink (2014, pp. 66-69) concluded that spruce-fir habitats in Colorado are only moderately vulnerable to the effects of climate change by mid-century under a moderate emissions scenario. Similarly, Keane *et al*. (*in press*, p. 209) concluded that while subalpine fir (*Abies lasiocarpa*; a major component of lynx habitats in western geographic units [3, 4, 5, and 6]) is likely to shift in distribution in the Northern Rockies, gains (expansion) will likely balance losses (contraction). They also concluded that Engelmann spruce (*Picea engelmanii*; also a major component of the 4 western geographic units), though highly sensitive to climate warming, will likely persist on the Northern Rockies landscape (Keane *et al*. *in press*, p. 213).

Upslope migration of boreal forest could occur either gradually or as a series of scattered, rapid advances as climate thresholds are crossed (Kupfer and Cairns 1996, p. 259-261) and may be limited by high winds, desiccation, and soil depths not conducive to conifer colonization. At lower elevations, the upslope movement of the deciduous-boreal ecotone is limited by excessively cold winter temperatures (generally -40°C [-40°F]), moisture (cloud, fog line), and acidic soils (Kupfer and Cairns 1996, p. 263-264). Boreal treelines in Scandinavia moved upslope an average of 40 meters (m; 131 feet [ft]), but in some locations up to 100 m (328 ft), during a recent 50-year period of warming (Kullman 1990, entire). In the Yukon, upslope

migration of spruce-fir seemed to be triggered by climate thresholds and was characterized by slow, gradual change followed by rapid advances (Danby and Hik 2007, p. 361). In Vermont, the northern hardwood-boreal ecotone moved upslope 91-119 m (299-390 ft) between 1962 and 2005 consistent with rapidly increasing cloud ceilings in the Northeast, which is believed to be closely associated with this ecotone transition (Beckage *et al.* 2008, pp. 4200-4201). Overall, the rate at which boreal forest could retreat upslope is highly speculative depending on how climate change may affect complex moisture and temperature regimes, and there could be a lag time before these community types shift (Kupfer and Cairns 1996, p. 268).

In summary, climate change is expected to further fragment boreal forest in southern Canada (Hogg 1994, entire) and in the contiguous United States, potentially reducing connectivity between lynx populations at the southern periphery of the species' range. As temperatures increase, lynx and hare habitats and, therefore, lynx distribution, are likely to recede northward and shift upward in elevation within its currently occupied range (Gonzalez *et al.* 2007, pp. 7, 13–14, 19; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, pp. 26–27, 30–31; Vashon *et al.* 2012, pp. 60, 64; ILBT 2013, p. 69). In the contiguous United States, researchers expect that lynx in mountainous habitat will, to some extent, track climate changes by using higher elevations on mountain slopes, assuming that vegetation communities supportive of lynx and hare habitats also move upslope with temperature and precipitation shifts (Gonzalez *et al.* 2007, p. 7). However, some areas of the DPS (e.g., Maine, Minnesota) lack such potential elevational refugia (Carroll 2007, pp. 1098-1102). Under a suite of emissions and climate change scenarios, boreal spruce-fir forests (lynx habitats) are projected to diminish dramatically and, under higher emissions scenarios, could largely or completely disappear from much of the DPS range by the end of this century (e.g., in Maine and Minnesota [Iverson and Prasad 2001, pp. 186, 195-196; Iverson *et al.* 2008, pp. 400, 403; Galatowitsch *et al*. 2009, pp. 2015-2016] and in the Rocky and Cascade Mountains in the west [Gonzalez *et al.* 2007, pp. 15-18; Johnston *et al.* 2012, pp. 6–13]). Under these scenarios and combined with projected impacts to snow conditions (see below), lynx populations would be anticipated to decline accordingly, with the potential loss of some DPS populations by the end of the century (Carroll 2007, pp. 1098–1102; Johnston *et al.* 2012, pp. 7-13). Although there remains much uncertainty regarding the timing, rate, and extent of modeled changes, ultimately, future northward and upslope contraction of lynx habitat in the DPS would likely result in fewer, smaller, and more isolated lynx populations that would be at increasing risk of extirpation resulting from demographic or environmental stochasiticty or genetic drift.

Northward and Upslope Contraction of Snow - As described above (section 2.2), the lynx's long limbs, large feet, and low foot-loading are believed to give it an advantage in snowy conditions over terrestrial competitors and predators. Although specific snow requirements for lynx (amount/depth, quality, persistence) have not been quantified throughout the DPS range, climate warming is diminishing snow conditions in the contiguous United States. Warmer winter temperatures are reducing snow cover extent and duration and altering snow structure via a combination of a higher proportion of precipitation falling as rain, more winter thaw-freeze events, higher rates of snowmelt during winter, and earlier spring melt and runoff (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Hoving 2001, pp. 73–75; Mote 2003a, p. 3–1;

Christensen *et al.* 2004, p.347; Knowles *et al.* 2006, pp. 4548–4549; Mote *et al*. 2008, entire; Pierce *et al*. 2008, entire; Abatzoglou 2011, entire; Vaughn *et al*. 2013, pp. 358-359; Georgakakos *et al*. 2014, pp. 71-85). These trends are expected to continue with projected future climate warming (Hamlet and Lettenmaier 1999, p. 1611; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 48; Christensen *et al*. 2007, p. 850; McKelvey *et al*. 2011, pp. 2887-2896; IPCC 2014b, p. 62). The IPCC projects that spring snow cover in the Northern Hemisphere is likely to decrease by 7-25 percent by the end of this century (IPCC 2014b, p. 62) and that ''snow season length and snow depth are very likely to decrease in most of North America except in the northernmost part of Canada where maximum snow depth is likely to increase'' (Christensen *et al*. 2007, p. 850). Because lynx occurrence is correlated with prolonged periods of deep, fluffy snow, current lynx habitats would be expected to decline in value for lynx with decreases in snow condition and duration (Hoving 2001, p. 73; Carroll 2007, pp. 1100-1103; Gonzalez *et al.* 2007, entire).

Warming in recent decades corresponded to a substantial decline in snow cover duration in North America, particularly in the mountains of the western United States (Mote *et al.* 2005, pp. 47-48; Kapnick and Hall 2012, entire). These areas have historically been snow-covered from November through March, but the length of snowfall-conducive temperatures over many western mountain ranges could be reduced from about 5 months to about 3 months (December-February) by mid-century (Klos *et al.* 2014, p. 4566). Spring snowpack has already declined in many parts of the Rockies, especially since the mid-20th century, despite overall increases in winter precipitation in many places (Mote *et al.* 2005, entire; Scalzitti *et al.* 2016, pp. 5367-5368). The recent rate of decline in the snowpack of the Northern Rockies is unprecedented in the last 1,000 years (Pederson *et al.* 2011, entire), and some mountainous regions appear to be warming faster than global land averages (Rangwalla and Miller 2012, entire). However, Oyler *et al*. (2015, entire) showed that systematic errors in temperature measurements at some Snow Telemetry (SNOTEL) sites resulted in the artificial amplification of mountain climate trends. In particular, during late spring the commonly used climate datasets (PRISM and Daymet) show elevation increases of 274 m (899 ft) and 487 m (1,598 ft), respectively, in minimum (snow-inducing) temperatures, while data with the systematic errors corrected show a statistically nonsignificant change of 66 m (217 ft; IDFG 2017a, p. 6). Nonetheless, the western United States has clearly warmed over the latter half of the 20th century, and this trend is very likely to continue into the future.

Estimating trends in snowpack is challenging because the high variability in snowpack dynamics and microsite variations due to canopy cover, aspect, and elevation are not well-reflected in observation records (Hubbart *et al*. 2015, pp. 885-892; Rasouli *et al*. 2015, pp. 3937-3938; Painter *et al*. 2016, p. 149; IDFG 2017a, p. 7). Nonetheless, snowpack losses have been documented and will likely continue and could even accelerate in the future (Hamlet and Lettenmaier 1999, entire; Payne *et al.* 2004, entire; McKelvey *et al*. 2011, entire; Kapnick and Hall 2012, pp. 14-16; Ashfaq *et al*. 2013, entire; Lute *et al*. 2015, 969-971), with faster losses likely in milder climates like the Cascades and the slowest losses in the high peaks of the Northern Rockies and Southern Sierras. For every 1°C (1.8°F) increase in temperature, snowline is projected to retreat upslope about 150 m (492 ft) in elevation (Beniston 2016, p.

106). In the West, areas of contiguous spring snow cover are projected to become smaller and more isolated throughout the Columbia, Upper Missouri, and Upper Colorado Basins, with greatest losses at the southern periphery (McKelvey *et al.* 2011, pp. 2892-2896). Snow accumulation and duration are also expected to continue to decline generally in the central and eastern portion of the lynx DPS range (Christensen *et al*. 2007, p. 891; Burns *et al.* 2009, p. 31; Moen *in* Lynx SSA Team 2016, p. 19). Similarly, because of diminishing snow resources, potential lynx habitat is diminishing in the northern Appalachians and small areas in the Canadian Maritime Provinces (Carroll 2007, p. 1093). An analysis of recent and potential future snow cover under a range of IPCC climate scenarios suggests that snow conditions correlated with historical lynx occurrence records could decline by 10-20 percent across the continental United States and Canada and by 46-84 percent in the contiguous United States by the end of the century (Gonzalez *et al.* 2007, pp. 4, 7, 12-14).

Across North America, a significant increase in the proportion of winter precipitation falling as rain rather than snow has also contributed to reduced depth and persistence of winter snowpack (Brown 2000, pp. 2347-2354; Dyer and Mote 2006, entire; Georgakakos *et al*. 2014, pp. 71-72) and increased snow density (Hodgkins and Dudley 2006, entire). Because winter temperatures have increased disproportionately, especially in the coldest northern tier states (Tebaldi *et al*. 2013, entire), the amount of winter precipitation falling as rain instead of snow has also increased throughout the DPS (Huntington *et al.* 2004, entire; Knowles *et al.* 2006, entire; Feng and Hu 2007, entire). If greenhouse gas emissions continue at the current rate, by 2100, the elevation above which it snows and below which it rains could climb as much as 244 m (800 ft) in the Colorado Rockies and by 423 m (1,400 ft) in the Rockies of Idaho and Wyoming, with the snow line projected to rise by an average of 290 m (950 ft) across 6 Western mountain regions (Scalzitti *et al.* 2016, p. 1564).

Shifts in the timing of the initiation of spring runoff toward earlier dates in western North America are also well documented (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Cayan *et al.* 2001, pp. 409–410; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 41; Knowles *et al.* 2006, p. 4554). In addition, a feedback (albedo) effect is likely to amplify regional warming and accelerate the rate of loss of snow cover because of the reflective nature of snow and the relative heat-absorbing properties of non-snow-covered ground (Vaughan *et al*. 2013, pp. 321, 358-361). This feedback effect causes the greatest warming to occur at the interface of snow-covered and exposed areas, increasing the rate at which melting occurs in spring (Groisman *et al.* 1994a, pp. 1637–1648; Groisman *et al.* 1994b, pp. 198–200). This effect has shifted the average date of peak snowmelt 3 weeks earlier in spring in the Intermountain West (Fagre 2005, p. 4). This albedo effect is further exacerbated by atmospheric soot and desert dust on the snow surface (Painter *et al.* 2007, entire; Qian *et al.* 2009, entire) and fire-darkened landscapes (Amiro *et al.* 2006, pp. 47-49).

Warming and more frequent winter rains and thaws are also contributing to changes in snowpack structure; namely replacing deep, unconsolidated snow with harder, crustier snow. These snow conditions are expected to occur at higher latitudes (Callaghan *et al.* 2011, entire) and higher elevations in the Rockies (Abatzoglou 2011, pp. 1138-1141). As winter temperatures

rise above freezing more often, rain on snow events and winter thaws become more common, causing changes in snowpack structure, including larger grain size, basal ice layers, depth hoar (weak layers in the snowpack), and slip planes (crusts and ice layers within the snowpack; Callaghan *et al.* 2011, p. 23). The frequency of winter warm spells is correlated to the hardness of the snow surface and sinking depth, which may influence the hunting efficiency of terrestrial hare predators (Murray and Boutin 1991, entire; Murray *et al*. 1994, p. 1450; 1995, p. 1209; Stenseth *et al.* 2004, p. 10633), potentially reducing the competitive advantage lynx are believed to have over some potential competitors (Pozzanghera *et al*. 2016, pp. 698, 703). These various forms of snow compaction and structure within the snowpack could give a competitive advantage to other terrestrial predators/competitors with higher foot-loading that would normally have difficulty traveling and hunting efficiently in deep, unconsolidated snow (Murray and Boutin 1991, entire; Murray *et al.* 1994, p. 1450; Kolbe *et al.* 2007, p. 1409).

The bobcat is the closest related species to lynx in North America, and bobcats occur within or immediately adjacent to all areas occupied by resident lynx populations in the DPS. Bobcats may outcompete or displaces lynx in some areas where the 2 species overlap, at both broad (Peers *et al.* 2013, entire) and local (Parker *et al.* 1983; Robinson 2006, pp. 120-129) geographic scales. In some areas of sympatry, lynx may be displaced to habitats of inferior quality, which could limit survival and productivity at the southern edge of their range (Robinson 2006, pp. 120; Peers *et al.* 2013, entire). Snow depth, consistency, and persistence likely mediate competition between the 2 species (Peers *et al*. 2012, pp. 4-9). Because of their higher foot-loading, bobcats likely hunt less efficiently than lynx in deep, unconsolidated snows (Hoving *et al.* 2005, entire; Krohn *et al.* 2005, pp. 122-129), which appear to limit bobcat mobility and distribution (Litvaitis *et al.* 1986, p. 116). Considering recent and projected future changes in snow conditions described above, stable or increasing bobcat populations in the DPS range (Roberts and Crimmins 2010, p. 170), and the predicted northward expansion of bobcats into areas currently occupied by lynx (Anderson and Lovallo 2003, p. 758; Lavoie *et al.* 2009, pp. 873-874; Roberts and Crimmins 2010, p. 172), lynx may experience increased competition and displacement by bobcats, which could influence lynx distribution and persistence at the southern edge of their range (in all DPS geographic units and in southern Canada).

Loss of favorable snow conditions could also result in increased lynx-bobcat hybridization. Thus far, hybridization has been documented in places (Minnesota, Maine, and New Brunswick) where low topographic relief and variability in winter severity may allow more interaction between the 2 species during the breeding season (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire; ILBT 2013, p. 34). The effects of hybridization on lynx populations in the DPS are uncertain, but it is not currently thought to be a substantial threat (Schwartz *in* Lynx SSA Team 2016a, p. 13). The hybridization rate is currently low (0.24 percent) but it could increase as bobcat populations are expected to move north with continued climate warming and related loss of snow conditions favoring lynx (Murray *et al.* 2008, p. 1465; Koen *et al.* 2015, p. 528). However, because lynx also are expected to shift northward with receding habitat conditions, it is possible that the zone of overlap between lynx and bobcats will shift northward but not increase in size, in which case an increase in hybridization rate would not be expected.

Although high-elevation areas in the western part of the DPS range (geographic units 3-6) may provide future snow refugia for lynx (Lynx SSA Team 2016a, p. 45), these areas will likely also be affected by continued climate warming, with lynx habitat distribution decreasing and isolation increasing as it moves upslope. Because recent and current rates of climate warming are much faster than occurred historically, it is possible that in these areas snow conditions favorable for lynx may move upslope at a faster rate than boreal forest vegetation, creating a mismatch of these lynx habitat elements. Thus, although it is possible that boreal forest vegetation may persist for some time, snow conditions thought to favor lynx could retreat upslope, potentially precluding lynx use of those boreal habitats and instead favoring potential competitors such as bobcats and coyotes.

Reduced Hare Populations and Densities – Climate change has also been linked to changes in the distribution of snowshoe hares in some parts of the southern edge of their range (Diefenbach *et al*. 2016, entire; Sultaire *et al.* 2016a, entire; 2016b, pp. 900-904). In Wisconsin, snowshoe hare range has contracted northward an average of 8.7 km (5.4 mi) per decade (1980-2014) and is projected to continue to recede northward with continued climate warming (Sultaire *et al.* 2016a, pp. 6-7). The authors concluded that loss of snow now contributes more than loss of habitat in determining the range of snowshoe hares in central Wisconsin (Sultaire *et al.* 2016a, entire). In Pennsylvania from 1983 to 2011, hare range contracted toward the coldest and snowiest areas in the northeastern and northwestern parts of the state, and continued warming may threaten the species' viability there (Diefenbach *et al*. 2016, entire). These 2 studies were of hare populations that do not now and apparently have not historically supported resident lynx populations, but similar contractions could occur in the future among hare populations within the range of resident lynx in the DPS.

Climate change also may affect hare populations in other ways, especially at the southern extent of its range in the DPS and in parts of southern Canada. As described above, changing snow conditions may influence lynx hunting behavior and effectiveness. For example, hard-packed snow is reported to be associated with a higher kill rate of hares by lynx and coyotes compared to soft snow (Buskirk *et al.* 2000a, p. 94; Stenseth *et al.* 2004, p. 10633). Consistently higher kill rates could generate numeric responses (population increases) by lynx and other hare predators (Hone *et al.* 2011, p. 420) that could drive hare populations to lower levels (Stenseth *et al.* 2004, p. 10633). Terrestrial hare predators are generally more diverse at the southern edge of the lynx range than in its core (Murray *et al.* 2008, pp. 1464-1465), and snow conditions that are projected to decreasingly favor lynx and increasingly favor less specialized predators (i.e., those with lower foot-loading) would be expected to result in increased predation on hares in some parts of their southern range.

Climate change is also projected to cause increases in annual precipitation and extreme precitpitation events as well as hotter summers and increasing drought across most of North America (Romero-Lankao 2014, pp. 1452-1456). Because the second litters of snowshoe hares have lower survival in wet summers (Meslow and Keith 1971, entire), increased precipitation may reduce hare numbers. However, because hares have 2 to 4 litters per summer, there is opportunity for compensatory survival of later litters if one is affected by weather (Krebs *et al.*

2014, p. 1043). Decreased hare survival may also be expected during prolonged hot, dry summer conditions. Conversely, in dry western forests, increased precipitation may result in more herbaceous forage and cover, which may promote hare survival and reproduction (Ivan *et al.* 2014, p. 590). Thus, climate change may have both positive and negative effects on hares.

The shorter duration and diminished snow cover in the DPS range is also causing an increasingly pronounced mismatch in the timing of hare color change that may reduce hare survival and result in population declines by the end of the century (Mills *et al.* 2013, entire; Zimova *et al.* 2014, entire; 2016, entire). Under a high emissions scenario, projected decreases in snowpack duration by as much as 4 weeks at mid-century and 8 weeks by the end of the century (Mills *et al*. 2013, p. 7362; Zimova *et al*. 2016, p. 304) could have population-level effects on hares at the southern edge of their range (Zimova *et al*. 2016, pp. 304-305). Hares exhibit plasticity in the rate at which they can molt from white to brown in the spring, but not in the initiation date of color change or the fall transition from brown to white (Mills *et al.* 2013, pp. 7362-7363). Hares do not seem to compensate for mismatched color by changing their behavior related to concealment, thus predisposing them to predation (Zimova *et al.* 2014, pp. 5-7). There is wide variability in the timing of pelage change by individual hares within populations, and "mismatched" hares experience increased mortality rates (Zimova *et al.* 2016, p. 302). Under high emission scenarios, hare survival could decline by 11 percent by mid-century and by 23 percent by late century (Zimova *et al*. 2016, p. 304). Lower survival could result in moderate (under a medium-low emissions scenario) to steep (high emissions scenario) declines in hare populations by late century (Zimova *et al.* 2016, p. 304).

This phenotypic color mismatch resulting in reduced hare survival, in conjunction with warming temperatures and decreased snow cover duration, is suspected of contributing to northward contractions of the snowshoe hare range in Wisconsin (Sultaire *et al*. 2016a, entire; 2016b, p. 902) and Pennsylvania (Diefenbach *et al*. 2016, p. 245). It is also possible that this phenological mismatch may affect hare cycles (Zimova *et al.* 2016, p. 305). The northward contraction of hares in Wisconsin over the past 3 decades occurred concurrently with a dampening of hare population cycles (Sultaire *et al.* 2016a, p. 7).

Although increased color mismatch and associated reduced survival have the potential to result in hare population declines as described above, natural selection acting on the wide individual variation in molt phenology might enable evolutionary adaptation/rescue (Zimova *et al*. 2016, p. 305) and the color mismatch should be corrected over time by strong natural selection pressure (ILBT 2013, p. 71; Moen 2017, p. 5). Such selection pressure may explain why snowshoe hares in some parts of the southern periphery of the range do not undergo pelage change in areas with no or little snow cover (e.g., in the Pacific Northwest; Dalquest 1942, pp. 167, 174-175; Nagorsen 1983, entire) or undergo only partial change to white in winter (in Pennsylvania; Gigliotti 2016, pp. 72, 89). However, with projected accelerated climate warming, it is uncertain whether adaptation via natural selection will be able to keep pace with rapid declines in snow cover duration at the southern edge of the snowshoe hare range (Sultaire *et al*. 2016a, p. 6).

Changes in the Frequency, Pattern, and Intensity of Disturbance Events - The distribution, amount, and composition of lynx habitat could be rapidly and dramatically altered by an increasing occurrence and persistence of drought, along with associated outbreaks of insects and pathogens, wind and ice storms, and wildfires (ILBT 2013, p. 70). All of these factors are potentially interrelated with multiple feedback mechanisms, and some have a cascading effect (Dale *et al.* 2001, p. 729). For example, drought can weaken trees, increasing their vulnerability to insects and pathogens. Insects and pathogens can create dead trees or increase fuel loads, potentially increasing the risk and intensity of fire. The boreal forest is a complex and variable system, and these effects are expected to vary in time and space and may interact. These interactions may appear slowly and be difficult to detect because of the typically long life spans of trees, or they may be manifested quickly after a catastrophic perturbation to the forest.

Drought and heat stress have already affected temperate and boreal forests (Allen *et al.* 2010, entire; Settele *et al*. 2014, p. 6), particularly in the West (geographic units 3-6), where tree mortality rates have increased rapidly in recent decades (van Mantgem *et al.* 2009, entire; Garfin *et al*. 2014, p. 464, 484; Joyce *et al*. 2014, p. 177-179; Mote *et al*. 2014, p. 495-496; Wade *et al*. 2017, p. 166). Increasing growing-season temperature is expected to increase episodic drought duration and/or intensity, which could increase evaporative demand, triggering moisture stress and increased forest vulnerability to periodic widespread regional mortality events (Joye *et al*. 2014, p. 179). Although much of the United States has experienced an increase in prolonged periods of excessively high temperatures and more severe droughts over the past 50 years (Melillo *et al*. 2014, p. 15), thus far it is not possible to attribute changes in North American drought frequency to anthropogenic climate change (Romero-Lankao *et al*. 2014, p. 1456). Nonetheless, some regional trends are apparent. For example, the drought over the last decade in the western United States suggests the driest conditions in 800 years based on tree ring data (Walsh *et al*. 2014, p. 38). Drought is projected to increase in much of the West by the middle and end of this century, including lynx geographic units 5 (GYA) and 6 (Western Colorado; Walsh *et al*. 2014, p. 41, fig. 2.22). Drought conditions are also expected to increase in the Northeast (which includes Unit 1 in Maine; Horton *et al*. 2014, p. 374), Midwest (which includes Unit 2 in Minnesota; Pryor *et al*. 2014, p. 425-426), Great Plains (which includes Unit 3 in western Montana; Shafer *et al*. 2014, p. 442); Northwest (which includes Unit 4 in Washington; Mote *et al*. 2014, p. 495), and Southwest (which includes Unit 6 in Colorado; Garfin *et al*. 2014, pp. 464-465, 468), with drought severity also expected in increase in Montana (Wade *et al*. 2017, pp. 155, 158-164). Increasing drought frequency and intensity are related to increased wildfire and forest insect activity in North America, including throughout much of the DPS range, with these trends expected to continue into the future (Groffman *et al*. 2014, pp. 203, 218; Joyce *et al*. 2014, pp. 176-178, 182; Melillo *et al*. 2014, pp. 9, 17; Romero-Lankao *et al*. 2014, pp. 1448, 1460-1461, 1477).

Wildfire frequency is increasing in boreal forests of North America, and extended fire seasons and increases in the total area burned are anticipated to continue in the western United States with continued climate warming (McKenzie *et al.* 2004, entire; Westerling *et al.* 2006, entire; Romero-Lankao *et al*. 2014, pp. 1447, 1461; Westerling 2016, entire). Evaluating wildfire patterns in the western United States from 1970-2012, Westerling (2016, pp. 5-10) found rapid

and dramatic increases in the frequency of large fires, wildfire durations, and the length of the wildfire season beginning in the mid-1980s. Mesic middle- and high-elevation forest types (such as lodgepole pine [*Pinus contorta*] and spruce-fir; i.e., lynx habitats) in the Northern Rockies experienced the greatest increases. Increased spring and summer temperatures and an earlier spring snowmelt strongly influenced large wildfires, suggesting that climate is the primary driver of these changes rather than fire exclusion (suppression), which appears to have had little impact on natural fire regimes of these higher-elevation forest types in this area (ILBT 2013, p. 70). Montana and Wyoming may be acutely sensitive to climate change and, even for a very mild climate-warming scenario, the area burned in the West could roughly double by the end of the century (McKenzie et al. 2004, p. 897). Increases are most likely in dry forests with high-frequency and low-intensity fire regimes (which typically do not provide lynx habitat); in areas of moderate fire frequency and intensity and areas of low frequency and high intensity fires regimes, habitat conditions for lynx may improve (McKenzie *et al*. 2004, p. 899). In contrast, climate change is increasing precipitation in boreal forest regions of eastern North America, which has reduced wildfire frequency (Bergeron *et al.* 2001, p. 388).

Under multiple climate scenarios, large increases in fire frequency are expected for boreal forests in central and western Canada, and reduced frequency in eastern Canada - a situation that reflects past Paleoclimates that were warmer than the present (Flannigan *et al.* 2001, pp. 860-862). Increased fire frequency at the grassland – aspen parkland – boreal forest transition in western Canada may hasten the conversion of boreal forest to aspen parkland and aspen parkland to grassland (Flannigan *et al.* 2001, p. 860-861), which could affect connectivity and gene flow in lynx populations. In the DPS range, large wildifres in north-central Washington (Unit 4) have reduced lynx habitat by 35-40 percent over the past 25 years (see section 4.2.4 below). Large wildfires have also occurred recently in lynx habitats in Units 2, 3, 5 and 6, though impacts to resident populations in those units have not been documented, estimated, or modeled.

Warming and drought are also likely affecting the frequency and intensity of some eruptive boreal forest insect pests and pathogens that affect disturbance patterns in spruce-fir forests (Volney and Fleming 2000, entire; Gray 2008, entire; Groffman *et al*. 2014, p. 203; Joyce *et al*. 2014, pp. 176-178; Melillo *et al*. 2014, p. 17). For example, native bark beetles, such as the spruce beetle (*Dendroctonus rufipennis*) and mountain pine beetle (*Dendroctonus ponderosae*), are key agents of change in coniferous forest ecosystems in western North America and have recently defoliated millions of hectares – among the largest and most severe outbreaks in recorded history (Bentz 2009, entire; USFS 2014, entire; Ivan *in* Lynx SSA Team 2016a, p. 23). Drought-stressed conifers have increased vulnerability to insect attack. Warmer springs also could increase the frequency and duration of wildfires, which in turn could increase vulnerability of surviving trees to bark beetle attack (Westerling *et al.* 2006; Bentz *et al*. 2010, p. 611; ILBT 2013, p. 70). Increasing temperatures and forest homogeneity could create conditions favorable for bark beetle outbreaks that exceed natural disturbance thresholds, perhaps increasing the likelihood of additional outbreaks in the resulting large areas of even-aged forests (Raffa *et al.* 2008, p. 512; ILBT 2013, p. 70). By the end of the century, changes in temperatures across the boreal forests of western North America may cause markedly high probability of outbreak of

these species (Bentz *et al.* 2010. pp. 607, 609). In contrast, the range of the spruce budworm, a major pest of spruce-fir ecosystems in eastern North America, is expected to shift northward, potentially reducing vulnerability of spruce-fir forests in Maine and Minnesota (Regniere *et al.* 2012, entire).

Climate change has also been implicated in increases in severe weather events. For example, in January, 1998 a severe ice storm extensively damaged the canopy of many northeastern United States and eastern Canadian forests, causing moderate to severe forest damage to over 40,000 km^2 (15,444 mi^2) in the Northeast United States and southern Quebec (Jones and Mulhern 1998, p. 19; Irland 2000, entire; Millward and Kraft 2004, entire). Ice storm damage to stands can range from light and patchy to total breakage of all mature stems over extensive areas (Irland 2000, entire). Similarly, in 1999, a derecho (severe wind-and hail-producing thunderstorm; Frelich *in* Lynx SSA Team 2016, p. 14) uprooted and snapped off trees in a 48 km- (30 mi-) long by 6-19 km- (4-12 mi-) wide swath of boreal forest in Unit 2 that impacted over 1,930 km^2 (745 mi^2)[13] of lynx habitat. It is uncertain how climate change may affect the frequency, intensity, location, and extent of ice storms and derechos; however, atmospheric warming will most likely shift the locations of prevailing ice storms northward.

In summary, natural disturbances (wildfire, forest insect outbreaks, and storms) are essential components of lynx habitats that historically have maintained the mosaic of forest stand seral stages and distriubutions that benefit lynx. Although these events may diminish lynx and hare habitats by removing forest cover, these impacts are typically temporary, and affected areas typically regenerate into the dense, young conifer stands that are associated with high hare and lynx densities throughout both species' ranges, including in the DPS. However, climate-mediated increases in the frequency, size, and intensity of these events may result in larger proportions of lynx habitats in a temporarily-unfavorable condition that occurs immediately post-disturbance and which may last for 10-40 years or more, depending on the nature of the disturbance and a suite of local climatic, topographical, and soil conditions. Such changes to historical disturbance regimes could affect a number of lynx demographic variables (e.g., distribution, density, survival, productivity) that influence population resiliency and, therefore, the likelihood that populations will persist on the landscape. For example, increased wildfire frequency, size, and intensity has affected over a third of the lynx habitat in Unit 4 over the past 25 years, resulting in increased lynx home ranges size and, therefore, lower density, likely reducing the population's resiliency compared to historical conditions (see sections 4.2.4 and 5.2.4, below).

Reduced Gene Flow between Canadian and DPS Lynx Populations - Koen *et al.* (2014a, entire) found that relatively lower neutral genetic diversity, lower allelic richness, and higher genetic differentiation among lynx at the trailing (southern) range edge in Ontario were correlated with high winter temperatures, low snow depth, and a low proportion of suitable habitat since the 1970s. The authors hypothesized that continued climate warming would increasingly create these unsuitable environmental conditions for lynx (e.g., milder winters with reduced snow quality, declining and fragmented boreal forest), at the trailing (southern) edge of the range. The

[13] https://en.wikipedia.org/wiki/Boundary_Waters%E2%80%93Canadian_derecho

authors surmised that genetic structuring in southern lynx populations could be caused by a northward shift in optimal conditions, potentially resulting in isolation and extirpation of lynx populations at the trailing edge of their range or climate-induced changes in the distributions of snowshoe hare or bobcats causing lynx to shift northward. Lynx with the greatest allelic richness were found in areas with the deepest snow in the core of their range in northern Ontario (Koen *et al.* 2014a, p. 758). The authors concluded that climate warming has reduced gene flow at the receding (southern) edge of the lynx's range, and that southward gene flow from Canada into threatened United States (DPS) populations is unlikely (Koen *et al.* 2014a, p. 760). Stenseth *et al.* (2004, entire) documented population and genetic structuring in the lynx populations east and west of Hudson Bay based on differences in snow conditions on either side of this divide. This may be explained by the reluctance of lynx to disperse between areas having different snow regimes and snow quality. Snow conditions may be the key factor in the spatial, ecological, and genetic structuring of Canada lynx (Stenseth *et al.* 2004, pp. 10633-10644).

Climate warming is expected to cause increased isolation of southern lynx populations, which could reduce gene flow by reducing connectivity between populations. For example, gene flow between lynx populations in Maine, New Brunswick, and eastern Quebec and more northern populations in Canada depends on an ice bridge for dispersal across the St. Lawrence River. Although some lynx currently cross the river, Koen *et al.* (2014a, entire) found genetic structuring on either side of the river. Thus, the river already restricts gene flow. Climate-induced deteriorating ice conditions on the St. Lawrence River could further restrict gene flow between lynx populations north and south of the river (Koen *et al.* 2015, p. 528). Between 1969 and 2002 there was a 20 to 40 percent reduction in sea-ice cover during the spring thaw in the Gulf of the St. Lawrence (Johnston *et al.* 2005, pp. 214-215). Conversely, reduced ice on the St. Lawrence may prevent bobcats from dispersing northward into lynx areas in central Quebec (Koen *et al.* 2015, p. 528).

The potential for genetic drift among DPS populations would be expected to increase at some point in the future if lynx and hare habitats shift northward and upslope, as projected with continued climate warming, resulting in reduced connectivity and gene flow among smaller and more isolated lynx populations at the periphery of the range. This would result in (1) smaller and more distant potential source populations in the southern Canadian provinces, reducing the likelihood and number of immigrant lynx reaching DPS populations, and (2) smaller effective population sizes (the size of an ideal population [i.e., one that meets all the Hardy-Weinberg assumptions] that would lose heterozygosity at a rate equal to that of the observed population) among DPS populations, making them more vulnerable to drift, the consequences of which could include lower survival and reproduction rates and loss of adaptive potential (Schwartz 2017, pp. 4-5).

Changes in the Periodicity and Amplitude of Northern Hare Cycles - Climate change is altering large-scale climate systems such as the North Atlantic Oscillation (NAO), Southern Oscillation, Pacific North American Index, and North Pacific Index which, in turn, affect patterns of temperature and snow in North America (Stenseth *et al.* 2003, entire). Climate change-induced disruptions are believed to have caused or contributed to the collapse of cycles in some voles

(*Microtus* and *Myodes* spp.) in northern Europe (Cornulier *et al*. 2013, entire) and lemmings in northern Finland (Ims *et al.* 2008, pp. 81, 84). The collapse of cycles in some herbivores with high-amplitude population cycles also would imply collapses of important ecosystem functions such as pulsed flows of resources and disturbances throughout the ecosystem, including declines in predator communities (Schmitz *et al.* 2003, p. 1202; Ims *et al.* 2008, p. 85).

A common denominator of cycles that exhibit spatial gradients, such as the more pronounced snowshoe hare cycles in the northern part of its North American range, is that the cycles seem to fade as winters become shorter (Ims *et al.* 2008, p. 81). Therefore, climate has also been hypothesized to influence snowshoe hare and lynx population cycles and synchrony (Hone *et al*. 2011, entire; Krebs 2011, pp. 484-488; Yan *et al*. 2013, entire). Hone *et al.* (2011, pp. 423-424) concluded that the NAO influenced both hare and lynx numbers and could dampen cycle oscillations. Yan *et al*. (2013 ,p. 3269) concluded that climate forcing is not only essential in producing sustained cycles, but also in modifying cycle intervals, and that greatly reduced lynx fur harvests in Canada beginning in the mid-1980s may be linked to climate warming. However, climate data analyzed by Krebs *et al.* (2013, pp. 566-572; 2014, pp. 1042-1043, 1046-1047) failed to explain changes in hare cycle synchrony documented in Alaska and western Canada beginning in about 1995. The authors rejected the hypothesis that climatic variation was correlated with hare-cycle amplitude in their study areas (Krebs *et al*. 2014, p. 1047), and their analyses did not support concern about collapsing population cycles hypothesized by Ims *et al*. (2008, entire).

Nonetheless, changes in large-scale climate systems have already influenced the climate and snow conditions throughout the geographic range of the lynx in North America (Stenseth *et al.* 1999, entire; Brown 2000, pp. 2347-2354; Krebs *et al.* 2001, p. 34; Stenseth *et al.* 2004, entire). If climate warming produces more pronounced troughs in hare abundance cycles in the interior of Canada, lynx populations would be expected to decline, though local extinction seems unlikely (Hone *et al.* 2011, p. 424). The potential for diminished lynx populations in Canada is a concern because periodic emigration from Canada is believed to influence the demographic and genetic health of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; USFWS 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789, 68 FR 40091, 40097-40100). Recent lower-amplitude hare cycles in southern Canada likely resulted in lower-amplitude lynx cycles as well, possibly resulting in muted irruptions with fewer dispersing lynx emigrating from Canada into the DPS. If these reduced cycles persist, they could result in reduced demographic support and gene flow into the DPS, both of which could influence the health and persistence of resident lynx populations in the DPS.

Increased or Novel Diseases and Parasites - Climate change can increase the distribution and transmission of parasites and pathogens and alter vectors, hosts, and host-susceptibility to disease. With continued warming, some species are predicted to experience more frequent or severe disease impacts with warming while others may be relieved of pathogens (Daszak *et al*. 2000, p. 444; Harvell *et al.* 2002, entire; Brooks and Hoberg 2007, entire; Harvell *et al.* 2009, entire). Climate change is likely to cause changes to the geographic range and incidence of

insect and tick-borne diseases (Daszak *et al.* 2000, entire). No apparent climate-influenced parasites or diseases have been identified that would be expected to broadly affect lynx or snowshoe hare populations, but several lynx experts believed this is difficult to predict and remains a possibility (Lynx SSA Team 2016a, pp. 27, 37-39). A few pathogens have been documented in lynx in the DPS. For example, plague, a flea-borne disease caused by the bacterium *Yersinia pestis*, which is not native to North America, was reported for the first time in lynx in Colorado (Wild *et al.* 2006, entire). Pneumonic plague appeared to be the direct or indirect cause of death of 6 lynx released in Colorado between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to *Y. pestis*; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado. Exposure of some lynx to feline parvovirus was detected in 6 areas in western North America (Montana-Alaska; Biek *et al.* 2002, entire). *Troglostongylus wilsoni* is a nematode that infects the lungs of lynx and bobcats (Sarmiento and Stough 1956, entire; Van Zyll de Jong 1966, entire; Kumar 1974, entire; and Reichard *et al*. 2004, entire) and was detected in Maine lynx (Vashon *et al.* 2012, p. 24). Lynx with heavy infestations have difficulty breathing and succumb to starvation, as occurred with several Maine lynx (Vashon *et al.* 2012, p. 24). Davidson *et al*. (2011, p. 242) hypothesized that toxoplasmosis could spread northward into lynx populations with changing climate and expanding ranges of humans and feral cats, cougars, and bobcats.

Summary – Well-documented climate warming over the past half-century has probably already had some impacts on lynx habitats in the DPS range, and such impacts are likely to continue and perhaps increase in the future. However, there currently is no clear evidence that climate change has had population-level effects within the DPS range or reduced the ability of habitats within the DPS range to support persistent resident lynx populations. However, such impacts would be difficult to detect and document, and lynx habitats in much of the DPS range are naturally highly-fragmented and many appear to support hare densities only marginally capable of supporting persistent lynx populations. Therefore, even relatively minor climate-mediated impacts to boreal forest habitats and snow conditions, especially to winter hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of the DPS range.

Although the rates of change and magnitudes of effects of climate warming are difficult to predict, climate models agree that lynx habitat and populations are likely to decline in the future, particularly at the southern margin of the range (Carroll 2007, pp. 1098–1102; Gonzalez *et al*. 2007, entire; Peers *et al*. 2014, pp. 1129-1134) and may disappear completely or nearly so from parts of the DPS range by the end of this century or sooner, depending on the intensity of greenhouse gas emissions (Galatowitsch *et al*. 2009, pp. 2015-2017; Johnston *et al.* 2012, pp. 6–13). Remaining lynx populations in the DPS range will likely be smaller than at present and, because of small population size and increased isolation, they will likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103) and to genetic drift (Schwartz 2017, pp. 4-5).

In addition to the factors discussed above, synergistic effects between them and other stressors (e.g., forest management, trapping, development) may intensify their impacts (Carroll 2007, entire) and could further reduce and isolate lynx populations within the DPS and reduce

connectivity between Canadian and DPS lynx populations and habitats. Declining boreal forests and snow conditions, increasing drought and fire, and increasing scale of forest insect outbreaks are currently believed to be the most important stressors for lynx in the DPS, but it is possible that other pathways are, or may also become, important. Potential climate-mediated changes in habitat, prey base, and competitor guild, along with ongoing habitat loss and fragmentation, has led some authors to question whether lynx will be able to adapt to such changes and persist at the southern periphery of the species' range (Murray *et al.* 2008, p. 1469). Largely because of the likely consequences of projected continued climate warming, lynx experts expect a decreasing likelihood that resident lynx populations will continue to persist in the future in the 5 geographic units that currently support them (Lynx SSA Team 2016a, pp. 35-47; see ch. 5, below). However, despite concerns about the long-term persistence of DPS populations, experts projected that resident lynx populations are very likely to persist in all 5 geographic units that currently support them in the near-term (year 2025) and mid-term (2050), and uncertainty was great regarding predicitons beyond that time frame.

3.3 Vegetation Management

Vegetation (i.e., timber) management is the most prevalent land use throughout the lynx DPS range and can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitats and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Vegetation management affects stand age, structure, composition, and arrangement on the landscape, which are important elements of lynx and hare habitat (ILBT 2013, p. 71). Timber harvest can create, restore, and maintain lynx and hare habitats, but it and related silvicultural activites (e.g., precommercial and commercial thinning, fuels management, fire suppression) can also diminish (often temporarily) habitat quality, quantity, and distribution; alter natural disturbance regimes; and preclude attainment of the dense horizontal cover that provides high-quality hare and lynx habitat (see section 2.2). The Service listed the lynx DPS under the ESA because of the potential for such activities to adversely affect lynx habitats and populations and the absence of measures to guide them for lynx conservation on Federal lands (68 FR 40076-40101).

At the home range scale, lynx throughout the DPS range consistently occupy landscapes having the greatest snowshoe hare densities. Although forest types and the effects of forest (vegetation) management vary geographically, hare abundance throughout the DPS range is strongly correlated with a single common denominator - dense horizontal cover at ground and snow level. Such cover provides hares with a source of browse, protects them from predation, and is the most important forest structural characteristics for hares throughout their range (Ferron and Ouellet 1992, pp. 2180-2182; Wolfe *et al.* 1982, pp. 665-670; Litvaitis *et al.* 1985, entire). Hare density is directly and positively correlated with stem density (Litvaitis *et al*. 1985, p. 870; Sullivan and Sullivan 1988, pp. 803-804; Koehler 1990b, entire; Thomas *et al.* 1997, pp. 24-50; Homyack *et al.* 2006, pp. 76-79; Robinson 2006, pp. 5-37, 67-75; Scott 2009, pp. 58-93; Fuller and Harrison 2013, pp.4-6), and softwood (e.g., spruce-fir) has about 3 times more cover value than hardwoods (Litvaitis *et al.* 1985, p. 870). Young (10-40 years post-disturbance) regenerating spruce-fir forests provide optimal cover and high hare densities throughtout the DPS range, and seral lodgepole pine and mature multi-storied spruce-fir stands may also

provide such conditions in the western part of the DPS range (Koehler and Brittell 1990, p. 10; Hoving *et al.* 2004, p. 290; Maletzke *et al*. 2008 p. 1477; Squires *et al.* 2010, pp. 1648, 1653–1656; McCann and Moen 2011, pp. 513-515; Berg *et al.* 2012, pp. 1483-1487; Holbrook *et al*. 2017, entire). Therefore, vegetation management practices that promote high stem density and dense horizontal cover can increase snowshoe hare densities (Conroy *et al.* 1979 pp. 684-689; Wolff 1980, pp. 115-128; Parker *et al.* 1983, pp. 783-785; Livaitis *et al.* 1985, p. 872; Monthey 1986, entire; Koehler 1990a, pp. 848-850, 1990b, entire; Robinson 2006, pp. 31-36, 62-75, 119-129; Fuller *et al.* 2007, entire; Homyack *et al.* 2007, entire; Scott 2009, pp. 8--92; McCann and Moen 2011, pp. 513-515), while forest practices that reduce dense understory generally reduce habitat quality for hares and lynx.

Historically, the dominant natural disturbance processes that created young, regenerating conifer forest conducive to hares and lynx were wildfire, insect and disease outbreaks, and wind events (Kilgore and Heinselman 1990, entire; Heinselman 1996, entire; Veblen *et al.* 1998, entire; Agee 2000, entire; Seymour *et al.* 2002, entire; Lorimer and White 2003, entire). After disturbances, forests generally develop through several stages described by Oliver (1980, pp. 155-161) as “stand initiation,” “stem exclusion,” “understory reinitiation,” and “old growth.” Stand dynamics, particularly within-stand competition for light, nutrients, and space, determine how forests grow and respond to intentional manipulations and natural disturbances (Oliver and Larson 1996, entire). The frequency and severity of disturbances have a large role in determining which tree species will dominate in a stand after the disturbance event. Snowshoe hare and lynx habitat are created during the stand initiation stage, after the young trees have established and grown tall enough (1-3 m (3-10 ft) to protrude above the snow and provide adequate horizontal cover. During the stem exclusion stage (when trees reach about 10 m [33 ft], depending on tree species) the tree crowns lift and lower branches self-prune, thus reducing the live horizontal branches providing food and cover for snowshoe hares. In the old growth stage, understory may re-develop (e.g., in forest gaps where mature trees die or fall down) and food and cover may again become available to support snowshoe hares.

Traditionally, commercial timber management of conifer forests has used a variety of silvicultural techniques (plantations, herbicide application, precommercial and commercial thinning, group selection, fuels management, and salvage and regeneration harvest) to (1) reduce tree density, promote tree growth, and select for desired species in young regenerating forests; (2) improve growth and vigor of mature trees; (3) reduce vulnerability of commercially-valuable trees to insects, disease, and fire; and (4) harvest forest products (ILBT 2013, p. 71). Just as the timing and intensity of a natural disturbance event affects the composition of the succeeding forest, the season, climate, machinery, and type of final harvest (e.g., clearcut v. partial harvest) all have a role in determining the species composition and health of the next crop of trees following management activities. Although some timber management practices may mimic natural disturbance processes, others, such as herbicide use and plantations, do not have natural analogues. Timber harvest may differ from natural disturbances in ways that may affect lynx and hare habitats, including (ILBT 2013, pp. 71-72):

- Removing most standing biomass, especially larger size classes of trees, and downed logs, which alters microsite conditions and nutrient cycling;
- Creating smaller, more dispersed patches and concentrating harvest at lower elevations in mountainous regions and on more nutrient rich soils, resulting in habitat fragmentation;
- Causing soil disturbance and compaction by heavy equipment, which may result in increased water runoff and slower tree growth at the site; or
- Giving a competitive advantage to commercially-valuable tree species and reducing the structural complexity of the forest through the application of harvest, planting, thinning, and herbicide treatments.

Therefore, vegetation management may or may not be compatible with creating, maintaining, or restoring habitats capable of supporting hares and lynx, depending on the extent to which conservation awareness and measures guide management. Vegetation management can provide snowshoe hare habitat by creating additional early-successional forest conditions in areas that are capable of, but not currently providing, dense horizontal cover; designing the appropriate size, shape and temporal pattern of treatment units (mimicking patterns created and maintained by natural disturbance regimes); retaining coarse woody debris; maintaining high stem densities in regenerated forests; and maintaining connectivity and dispersal habitat (Koehler and Brittell 1990, pp. 11-12; Homyack *et al.* 2004, pp. 141-142; Bull *et al.* 2005, entire; Fuller and Harrison 2005, p. 719). However, forest management can also diminish lynx and hare habitats by removing cover, altering natural disturbance patterns and regimes, creating unnaturally large or continuous openings, fragmenting habitat, and eliminating connectivity/dispersal habitats. Roads associated with forest management also fragment habitat and can increase access by competing predators and humans, both potentially affecting lynx habitats and populations.

Forest Products Markets - North America is the world's leading producer and consumer of wood products. Therefore, worldwide trends in forest products markets greatly affect forest management decisions, which may influence the amount and quality of lynx habitat in the DPS. Globalization of manufacturing and expanded use of electronic media have reduced demand in pulp and paper since the late 1990s, and the collapse of housing construction, which deepened with the recession of 2007-2009, has contributed to declines in United States wood products output. In recent years, the nation's forest products industry experienced a downturn in output levels not seen in decades, with considerable declines in timber harvest, mill numbers, and wood consumption since 2000, and employment losses in the hundreds of thousands (Woodall *et al.* 2011, p. 595).

Forest management decisions (e.g., to focus on hardwood or softwood production) can change dramatically in response to unpredictable and changing forest products markets. Lynx occur in forests dominated by softwood conifers; therefore, management related to softwood production and harvest has the greatest potential to affect lynx populations in the DPS range. Because they depend on demand for paper and housing, markets for softwood products are affected by economic factors that are difficult to predict and are therefore particularly volatile. For example,

the western United States, a major softwood lumber producing region, was particularly hard hit by the recession and housing collapse - forest industry employment dropped by 30 percent (nearly 80,000 workers) and annual output value fell by more than 25 percent (Keegan *et al.* 2011). Under depressed markets, landowners may reduce harvests, which may be to the detriment of lynx in some parts of the DPS (e.g., Maine and Minnesota), but to their benefit in others (the western part of the range). Likewise, rapidly expanding (recovering) softwood markets could lead to rapid and extensive harvest, with potential benefits or detriment to DPS populations, depending on local cicumstances and landscape habitat conditions.

Despite depressed markets, one area of increasing interest is bioenergy production. Rising energy costs and growing concerns over global climate change have increased interest in bioenergy production, and the United States Energy Independence and Security Act (2007) mandates a 5-fold increase in biofuel production (Benjamin *et al.* 2009, p. 125). The wood pellet sector is expected to grow, although woody biomass is typically the lowest value wood commodity sold from the forest. Thus, it is questionable whether wood energy revenues would be enough to sustain forest investments and forest management into the future (Woodall *et al.* 2011, p. 601) and, therefore, potential impacts or benefits to lynx habitats and populations are uncertain.

Although management of State and Federal forest lands has been relatively stable in recent decades, management and ownership of private forest lands have been comparatively unstable. This has resulted in substantial shifts in forest management strategies, outcomes, and products. For example, in the last 2 decades in Maine, where nearly all the lynx critical habitat is on private land, about 96,315 km^2 (37,187 mi^2; 80 percent) of commercial timber lands in the "northern forest" (Adirondacks to northern Maine) were sold to many different kinds of financial groups (Hagan *et al.* 2005). These groups have short-term investment goals and their management objectives differ from traditional commercial timber operations, resulting in changes to traditional harvest practices. Whereas the previous large commercial timber landowners focused on the forest land base as a supply for their manufacturing facilities, the new Timber Investment Management Organizations (TIMOs) and Real Estate Investment Trusts (REITs) focus on maximizing return on their investment (Jin and Sader 2006, p. 178). Initially, the effects of ownership changes were uncertain (McWilliams *et al.* 2005), but an evaluation of harvesting in the last decade indicates these landowners increased harvest rates, shortened rotation times, and shifted to managing and harvesting hardwood tree species (Jin and Sader 2006, p. 183-185). On one hand, these trends in private lands management in Maine may make lynx conservation more difficult to achieve because short-term landowners may be less interested in long-term commitments. On the other hand, some easement owners may have an incentive to manage for lynx to meet forest certification requirements.

The extensive sale of private forestlands initiated the growth of conservation easements in this region (deGooyer and Capen 2004; Lilieholm *et al.* 2010). Conservation land as a percentage of Maine's State area increased from less than 5 percent in 1987 to approximately 19 percent by 2012 (Beck *et al.* 2012, p. 15). Conservation easements restrict development but usually do not affect forest management; neither do they typically require management for lynx and other rare

species. Some private forestlands were sold to State and Federal agencies and conservation interests. For example, in recent years The Nature Conservancy purchased over 125,000 ha (310,000 ac) of private forestland in Montana and nearly 75,000 ha (185,000 ac) of private forestland in northern Maine. Lands in conservation ownership are more likely to be managed to benefit hares and lynx.

Finally, future trends in forest management will likely be affected by climate change (Irland *et al.* 2001, entire). Many models have been developed to project how United States timber production and markets may adapt to climate change (e.g., Joyce *et al.* 1995; Burton *et al.* 1998; Sohngen and Mendelsohn 1998; Perez-Garcia *et al.* 2002). Economic models predict that with continued climate warming, total United States timber inventories will increase, timber harvest will increase, and product prices will decrease relative to an assumed stable climate. Some models predict that consumers will gain from climate change while landowners in some regions will lose. The forest industry will likely adapt to climate change in many ways including using alternate tree species in manufacturing, shifts to geographic regions of the country with economic advantages in timber growth, and increasing forest plantations with new species that are favorably adapted to the new climate and markets. Many strategies have been evaluated to increase the quantity of carbon stored in North American forests (Irland *et al.* 2001) including discontinuing or greatly reducing harvest in some forests to build carbon reserves, increased recycling to reduce use of forest products, converting agricultural lands to forests, and substituting wood products for more energy-intensive products. Increased atmospheric carbon will increase forest growth slightly, except for softwood (Irland *et al.* 2001, p. 757-758). Sawtimber production, which sequesters more carbon, is expected to increase (Irland *et al.* 2001, p. 758). Expanding landscapes with older growth conifer forest to sequester carbon could benefit lynx in the West and be to the detriment of lynx in the East.

Reduced Quality of Hare Habitat - Throughout the lynx DPS, some vegetation management practices, especially thinning in young, dense regeneration; reducing overstory canopy in mature multi-story spruce-fir forests (in the West); and partial harvesting (in northern Maine) reduce the quality of boreal forest habitats for snowshoe hares and lynx. The probability of lynx occupancy of a potential home range is sensitive to small changes in average hare density (Simons 2009, pp. 89-110; Simons-Legaard *et al*. 2013, pp. 572-576). Below a threshold of about 0.5 hares/ha (0.2 hares/ac), declines in hare abundcance, whether from natural population fluctuations (hare cycles) or habitat loss or fragmentation from detrimental forest practices, development, or other anthropogenic incluences could be sufficient to diminish landscape carrying capacity for lynx (Scott 2009, p. 118). Such declines could result in reduced productivity (Slough and Mowat 1996, pp. 953-956), cause lynx to increase home range sizes (Scott 2009, p. 120; Ward and Krebs 1985, entire; Mowat *et al*. 2000, pp. 276-280) or, in extreme cases, to abandon their home range or cause mortality (Ward and Krebs 1985, p. 2819; Slough and Mowat 1996, pp. 956-957).

Thinning of young, dense sapling stage conifers (precommercial thinning) is a forest management practice used widely throughout the DPS to increase the growth and value of selected trees and to reduce the time to maturity of a stand of trees. Precommercial thinning

removes competing trees of the same species or shrubs and trees of other species (Daniel *et al.* 1979; Homyack *et al.* 2005, 2007). The effects of precommercial thinning are summarized in the revised Lynx Conservation Assessment and Strategy (ILBT 2013, pp. 72-73):

> *Reducing the density of sapling-sized conifers in young regenerating forests to increase the growth of certain selected trees promotes more homogeneous patches and reduces the amount and density of horizontal cover, which is needed to sustain snowshoe hares (Sullivan and Sullivan 1988, Hodges 2000b, Griffin and Mills 2004, Ausband and Baty 2005, Griffin and Mills 2007, Homyack et al. 2007, Ellsworth 2009). Hares reach highest densities in stands with stem densities ranging from 4,600–33,210 stems/ha (1,862–13,445 stems/ac)(Wolff 1980, Parker 1984, Litvaitis et al. 1985, Monthey 1986, Parker 1986, Koehler 1990a, Griffin 2004, Fuller and Harrison 2005, Robinson 2006, Scott 2009), whereas thinned stands have densities of 2990 (6-foot spacing) to 1,682 (8-foot spacing) stems/ha (Pitt and Lanteigne 2008, p. 593). Precommercial thinning has been shown to reduce hare numbers by as much as 2- and 3-fold (Griffin and Mills 2004, 2007; Homyack et al. 2007) because of reduced cover and decreased availability of browse. Griffin and Mills (2007) reported that, if their results were representative, the practice of precommercial thinning could significantly reduce snowshoe hare populations across the range of lynx.*
>
> *There are anecdotal examples of precommercially thinned stands that subsequently "filled in" with understory trees. Some have suggested this could be a technique to extend the time that understory trees and low limbs provide the dense horizontal cover that constitutes snowshoe hare habitat. The duration between time of thinning and regrowth to a height providing winter snowshoe hare habitat would likely vary by tree species, each having different regenerative capacities that could be influenced by a variety of local factors (e.g., topographic relief, moisture, and mineral and organic content of the soil; Baumgartner et al. 1984, Koch 1996). Bull et al. (2005) reported that the slash and coarse woody debris remaining after precommercial thinning provided both forage and cover for snowshoe hares up to a year following treatment. However, Homyack et al. (2007) found that snowshoe hare densities were reduced following precommercial thinning for 1–11 years post-thinning. They further suggested that after precommercial thinning, the stands did not regain the structural complexity in the understory that would be needed to support pre-treatment snowshoe hare densities. At this time, no other data are available to quantify the re-establishment of snowshoe hare habitat and over what time period, or the response by snowshoe hares, as compared with sites that were not precommercially thinned, so this remains an unproven management technique. As an alternative to standard precommercial thinning (i.e., complete thinning resulting in a homogeneous patch), Griffin and Mills (2007) suggested retaining at least 20 percent of the patch in untreated clumps of about ¼ ha (½ ac), which would maintain hare habitat in the short term. However, Lewis et al. (2011) found that landscapes with patches of high-quality habitat surrounded by similar vegetation supported more hares than did more fragmented landscapes composed of high-quality*

patches in a matrix of poorer-quality habitat. Further long-term studies of modified thinning methods are needed.

Abele *et al*. (2013, entire) also found that precommercial thinning reduced hare abundance in western Oregon but did not affect individual hare survival or activity patterns. Because of documented adverse effects of precommercial thinning to snowshoe hares and lynx, in 2007 and 2008 the USFS amended Forest Plans to incorporate management that would conserve lynx, including direction that prohibited precommercial thinning in most lynx foraging habitat (USFS 2007, pp. 8, 11-14, 36; USFS 2008a, pp. 6-9, 23-26). However, precommercial thinning is not regulated on private forest lands throughout the remainder of the DPS.

Particularly in western forest systems, uneven-aged management (single tree, partial harvest, and small group selection) can be used in stands with poorly developed understories, but which have the potential to develop dense horizontal cover. In such stands, removing some large trees can create openings in the canopy that mimic natural gap dynamics and maintain or stimulate multi-story attributes (ILBT 2013, p. 73). However, creation of large openings may discourage use by lynx (Koehler 1990a; von Kienast 2003; Maletzke 2004; Squires *et al.* 2010; ILBT 2013, p. 73), at least temporarily. Removing larger trees from mature multi-story stands to reduce competition and increase tree growth or resistance to forest insects may degrade lynx winter habitat by reducing horizontal cover (Robinson 2006; Koehler *et al.* 2008, Squires *et al.* 2010). Similarly, removing understory trees from mature multi-story stands also reduces dense horizontal cover, reducing winter habitat quality for both hares and lynx (ILBT 2013, p. 73).

In eastern forests, partial harvesting practices diminish (compared to regeneration following large-scale clear-cutting) the development of large patches of dense horizontal cover for snowshoe hares (Simons-Legaard *et al*. 2016, pp. 7-8). Partial harvesting broadly describes many methods of removing a portion of the overstory trees from a forest stand. Partial harvesting includes selective cuts, shelterwood cuts, and uneven-aged management. Partial harvest may be “light” (e.g., < 10 percent of trees removed) to “heavy” (e.g., 90 percent of trees removed). Since passage of the Maine Forest Practices Act in 1989, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine (Sader *et al.* 2003, entire). In recent years, almost 172,000 ha (425,000 ac) of Maine forest are harvested annually and 96 percent of this land is partially harvested (Maine Forest Service 2016). After 28 years of extensive partial harvests, much of the northern Maine landscape has been influenced by this form of forestry, and will continue to be into the future. The popularity of this form of harvesting extends beyond Maine. From the mid-1980s to mid-1990s, partial harvesting comprised 62 percent of the harvest in the United States, and clearcuts comprised the other 38 percent. Partially harvested stands result in a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006). On average, partially harvested stands in Maine supported about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006; Harrison *et al*. 2016 p. 55; also see sections 4.2.1 and 5.2.1, below).

Shelterwood harvesting (sometimes referred to as overstory removal) is a form of even-aged management most frequently used in hardwood and mixedwood stands in Maine (Rolek 2016, *unpubl. data*, Maine Cooperative Fish and Wildlife Research Unit), but also in spruce and fir stands (Pothier and Prevost 2008, entire). Shelterwood harvests that occur in predominantly softwood stands contribute to landscape hare densities to support lynx; however, hare density in regenerating shelterwood stands was only about half that of regenerating clearcut and herbicide-treated stands (D. Harrison, Univ. Maine, *pers. comm.* and *unpubl. data*; Harrison *et al*. 2016, p. 55). Regenerating shelterwood harvests in softwood stands are less likely to support higher landscape hare densities because they are most often done in small patches to avoid problems with windthrow, especially in wet soils (D. Harrison, Univ. Maine, *pers. comm*.). As much as 30 to 40 percent of the advanced regeneration may be damaged from repeated entries by machinery to remove the overstory (R. Seymour, Univ.Maine, *pers. comm.*). Finally, because subsequent overstory removal occurs about 15 years after the initial entry, some of the dense understory is damaged just as the stand develops conditions to support higher hare densities. The damage to the understory not only reduces the quality of the habitat for hares, but also cuts short the duration that the stand produces high-quality hare habitat.

Fuels treatment and biomass removal projects also may reduce hare and lynx habitat quality. Fuels treatment projects are typically designed to remove understory biomass and reduce stem density in forests that are outside their historical range of variability, and to clear fuels adjacent to human developments for safety or to protect investments (ILBT 2013, p. 74). Removing or reducing the understory and ladder fuels to meet those objectives reduces horizontal cover important to snowshoe hares and thus diminishes lynx habitat quality (ILBT 2013, p. 74). In the West, most of these projects occur in dry, lower-elevation forests where past fire suppression has resulted in unnatural fuel build-ups; however, these are not lynx habitat. In the Great Lakes Region, prescribed burning to reduce fuels and mimic a more natural fire regime in lynx habitat causes a short-term (10–30 years) impact on snowshoe hare habitat (ILBT 2013, p. 75). Biomass removal for energy production targets the removal of dead trees, logging slash, and small-diameter trees and shrubs. Biomass removal is similar to fuels treatments in reducing cover and habitat for snowshoe hares (ILBT 2013, p. 75).

Loss, Degradation, and Fragmentation of Boreal Forest Habitat - Forest management rarely results in conversion of lands to non-forest. In fact, forested landscapes have increased in some parts of the DPS (especially in the Northeast) because of farm abandonment and recolonization by second-growth forest. However, some forms of forest management such as selective harvesting and fire suppression can (intentionally or unintentionally) alter tree species composition away from boreal forest types that support snowshoe hares and lynx. Similarly, lack of forest management can alter tree species composition (Trani *et al.* 2001, pp. 415-417). Other stressors, such as insect outbreaks and climate change, can work in synergy with forest management to reduce boreal forest. For example, in northern New England clearcutting sometimes leads to drying of the forest floor and consequent heavy mortality in spruce and fir regeneration and increased light levels that increase hardwood competition (White and Cogbill *in* Eagar and Adams 2012, p. 32).

Plantations can convert native forest communities into monocultures of a native or exotic tree species that may lack hardwood browse for snowshoe hare. Cutting rotations can be reduced by half through mechanical site preparation, planting, and suppression of hardwood competition. Conifer stem densities in plantations range from 800-5,000 stems/ha and may support relatively low populations of snowshoe hares because of the initial wide spacing of trees (Bellefeuille *et al.* 2001, p. 44). Hare densities in plantations may increase after trees reach the sapling stage and branches intermingle at the ground level, creating horizontal cover if the lateral branches are not pruned (Parker 1984, p. 163; Parker 1986 p. 160; Roy *et al.* 2010, p. 285). However, the period of time that spruce plantations may support high hare densities in Maine and eastern Canada may be relatively short (10 to 17 years post-harvest) compared to regenerating softwood clearcuts (15-35 years post-harvest; Simons-Legaard *et al.* 2013, p. 569).

Under certain forest stand conditions, herbicide treatment may have long-term effects on stand composition and structure (MacLean and Morgan 1983; Daggett 2003), thus potentially reducing food, cover, and habitat for hares (Borrecco 1976; Bellefeuille *et al.* 2001, p. 43; Thompson *et al.* 2003 p. 462). Understory deciduous stems were lacking in stands treated with herbicide (Homyack *et al.* 2004). Although herbicide treatments reportedly do not directly affect survival, fecundity, or other demographic parameters of snowshoe hares (Sullivan 1996), treatments have indirect effects on hares via changes in vegetative cover and browse (Homyack *et al.* 2005, p. 10). In Norway, hare use of plantations was reduced up to 10 years after herbicide application (Hjeljord *et al.* 1988).

Forest management can fragment and isolate patches of high-quality hare habitat (Simons-Legaard *et al.* 2016). Fragmentation of the already naturally patchy pattern of lynx habitat in much of the contiguous United States can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation from forest management can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. For example, in Maine the proliferation of partial harvesting will actually increase the patches of high-quality hare habitat by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6).

Changes in Frequency and Pattern of Disturbance Events - Prior to European settlement, the dominant natural disturbance processes that created early-successional stages within the range of the lynx were wildfire, insect and disease outbreaks, and wind events (Kilgore and Heinselman 1990; Veblen *et al.* 1994; Heinselman 1996; Agee 2000; Seymour *et al.* 2002; Lorimer and White 2003). In the DPS range, fire was more important in the West and Great Lakes areas and less a factor in the Northeast, where insects and wind events predominated. Today, natural disturbances, especially fire and insect outbreaks, remain the predominant forms of disturbance in boreal forests throughout much of the lynx's range, including the western

contiguous United States, where they also influence and interact with forest management. However, forest management (i.e., timber harvest) is an important disturbance agent in some boreal forest types in the DPS range and, in some instances has greatly altered the natural disturbance regime. For example, prior to logging, the Acadian forest in Maine and eastern Canada likely exhibited forest gap dynamics similar to some parts of the West today, and true stand-replacing disturbances were quite uncommon with recurrence intervals of hundreds to thousands of years. After several centuries of forest management, stand age structures in the Acadian forest have become simplified, and commercial timber rotations (harvesting schedules) are a fraction (15 to 40 percent) of the lifespan of boreal tree species (Seymour 2002). Although the prevalence of these younger even-aged forest stands on the landscape may benefit hares and lynx in Maine, forestry has shifted the species composition of Maine's forest to tree species favored by frequent harvest disturbance, such as red maple (*Acer rubrum*), paper birch (*Betula papyrifera*), aspen (big-toothed [*Populus grandidentata*] and quaking [*P. tremuloides*]), and balsam fir (*Abies balsamea*).

3.4 Wildland Fire Management

Wildfire is a natural and essential component of boreal and montane forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger *et al.* 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Wildfire creates and maintains lynx habitats by providing periodic vegetation disturbances that result in the spatial and temporal distribution of early-successional forest stands or patches within older stands featuring dense horizontal cover at ground and snow level. These stands/patches provide high-quality hare foraging habitat and typically support high hare densities, which in turn provide high-quality lynx foraging habitat. They are generated by (1) high-intensity, stand-replacing fires that result initially in removal of all or most vegetation, followed by regeneration of dense horizontal cover, or (2) low- or moderate-intensity fires that stimulate understory development in older stands without killing all the overstory, resulting in patches of dense horizontal cover within multi-story stands (Agee 2000, p. 53; Ruediger *et al.* 2000, p. 7-6). These habitats become most favorable for hares and lynx when regenerating conifers grow tall enough to protrude above the snow, providing cover and food for hares throughout the winter (ILBT 2013, pp. 10-12). They remain important as winter foraging habitat, which may be the most limiting habitat for lynx (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 17, 27), until they reach the stem-exclusion structural stage and self-pruning results in the loss of dense horizontal cover above the snow, or until another disturbance resets them to the stand-initiation structural stage (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 1-3; ILBT 2013, p. 27). The length of time to achieve favorable hare and lynx habitat after fire (or other vegetation disturbance) and the duration for which those conditions persist vary across the lynx range depending on soil and vegetation potential, temperature and precipitation patterns, topography, fire intensity, and perhaps other local conditions (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 2-5; ILBT 2013, pp. 27-29, 75). Generally, regenerating forests in the DPS range may begin providing winter hare habitat within 10-20 years after fire or other disturbance, with favorable conditions persisting for 20-30 years after that (Koehler and Aubry 1994, pp. 86-87;

Agee 2000, pp. 67-71; Fuller *et al.* 2007, p. 1985; McCann and Moen 2011, p. 515; Vashon *et al.* 2012, p. 15; ILBT 2013, pp. 28-29), although it may take longer, perhaps 35-40 years, for lynx habitat to recover in some parts of the range (e.g., Maletzke *in* Lynx SSA 2016a, p. 21).

Fire frequencies, sizes, intensities, and return intervals also vary across the range of the lynx and depend on local vegetation communities, climatic conditions, and topography (Agee 2000, pp. 47-56; Ruediger *et al.* 2000, p. 4-8; ILBT 2013, pp. 75-76). In lynx habitats, fire intensity is typically high and fire return intervals long but variable, with large areas affected by infrequent stand-replacing fires and, in mixed fire regimes, moderate- or low-intensity fires in the intervals between stand-replacing events (Agee 2000, pp. 49-54; Ruediger *et al.* 2000, pp. 4-8, 7-6). Within the DPS range, fire return intervals in the Great Lakes Region appear similar to those in the core of the lynx's range in the Canadian and Alaskan taiga (roughly 50-150 years), with longer return intervals in Western (150-300 years) and Northeastern (up to 500 years) forests (Agee 2000, pp. 52-53; ILBT 2013, pp. 75-76). Despite these long intervals, fire is the dominant natural disturbance mechanism in lynx habitats in the DPS range except in the Northeast, where insects and wind are more important (Agee 2000, p. 53).

Current Federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI *et al.* 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Calkin *et al.* 2015, pp. 1-3) which, combined with other land-use practices, dramatically altered fire regimes in some places and created conditions prone to larger and more severe fires (USDI *et al.* 2001, p. 1-2). Because of (1) fire's important role in creating and maintaining high-quality early-successional hare habitat in most lynx habitats in the contiguous United States, (2) the potential for fire suppression to alter this dynamic to the detriment of hares and lynx, and (3) the limited ability of land managers (at that time) to use fire to benefit hares and lynx, wildland fire management was identified as a "Lynx Risk Factor Affecting Lynx Productivity" (Ruediger *et al.* 2000, pp. 2-5, 5-2). To address these concerns, the authors developed objectives, standards, and guidelines for Federal land managers to restore fire's role in maintaining lynx habitats, attempt to mimic historical natural fire regimes, and integrate lynx habitat objectives into fire management plans (Ruediger *et al.* 2000, pp. 7-6 - 7-8). They also directed Federal land managers to evaluate whether fire suppression or other management practices had altered fire regimes and ecosystem function in potential lynx habitats and, where so, to use fire (naturally ignited fires or prescribed burns) as a tool to restore and maintain lynx habitat by creating or regenerating snowshoe hare habitat (Ruediger *et al.* 2000, p. 7-7).

In its 2000 listing rule and 2003 remanded determination, the Service recognized the potential for fire suppression to adversely affect lynx and hare habitats at local and regional scales, particularly in the Great Lakes Region, where fire suppression policies across land ownerships likely prevented fire from assuming its natural role in creating a landscape mosaic of vegetation communities and age classes (65 FR 16076; 68 FR 40095). In the Northeast, the Service concluded that the very long fire return intervals and maritime influence in lynx forest types

indicated that fire did not historically play a significant role in creating or maintaining lynx and hare habitats and thus fire suppression was unlikely to have affected lynx habitat (68 FR 40094). In the West, the Service concluded that the effects of fire suppression were likely lower in lynx forest types because of their typically long fire return intervals compared to lower and drier forest types (65 FR 16074; 68 FR 40093-94). Overall, the Service concluded that fire suppression did not represent a threat to lynx in the Northeast and was a low-magnitude threat in the Great Lakes, Southern Rockies, and Northern Rockies/Cascades (65 FR 16075-16076; 68 FR 40093-40098).

In response to the guidance provided in the LCAS, the USFS, when developing the NRLMD and the SRLA to amend forest plans to address lynx conservation (see 3.1.1), evaluated whether fire suppression had adversely affected potential lynx habitats on national forests in the Northern and Southern Rockies. The USFS concluded that many forests in potential lynx habitat are in Condition Class 1, which means they have not missed a fire cycle because large, stand-replacing fire only occurs every 100 to 200 years; the long fire return interval has not been affected to any large degree by more recent fire suppression as is the case in drier forests with short fire return intervals; and they are close to historical conditions (USFS 2007, pp. 18, 20; USFS 2008a, p. 11). In addition to the national forests covered by the NRLMD and SRLA (all national forests in the Northwestern Montana/Northeastern Idaho, GYA, and Western Colorado geographical units), the Superior National Forest, which accounts for 45 percent of the Northeastern Minnesota unit, revised its forest plan to adopt lynx conservation measures consistent with the LCAS (USFS 2004a, Appendix E). The Okanogan-Wenatchee National Forest in the North- central Washington unit is currently revising its management plan and continues to manage for lynx conservation in accordance with the LCAS, including direction to restore fire to its natural ecological role and to use it as a tool to restore and maintain hare and lynx habitats.

As described above in section 3.1.1, current Federal management on most USFS and BLM lands, in accordance with formally revised or amended management plans, includes limits on the proportion of lynx habitat within LAUs that can be in an unsuitable condition at any given time, including such conditions, usually temporary, created by wildfire. Although some exemptions and exceptions to these limits are permitted for activities to reduce fire risks to communities and infrastructure in the wildland-urban interface (WUI) or to achieve other resource benefits, even these potential impacts are limited on the larger landscape scale (USFWS 2007, p. 7). These conservation measures and the direction to use fire management (as well as timber harvest/vegetation management) as a tool to restore hare and lynx habitats and return to natural temporal and spatial patterns of fire disturbance, which were not in place when the DPS was listed, likely further reduce what was even then considered the low potential threat to lynx of past fire suppression activities. Based on the information above, we conclude that fire suppression and other fire management activities have not substantially impacted lynx and hare habitats in the DPS range and are unlikely to do so in the future.

However, warming temperatures attributed to climate change are reducing snowpack, causing earlier snowmelt and longer and more extensive droughts, resulting in longer wildfire seasons

and increased fire frequency, size, and intensity in boreal forests of the north and in boreal and montane forests in some parts of the DPS range (Weber and Flannigan 1997, entire; Stocks *et al.* 1998, entire; Gillett *et al.* 2004, entire; Kasischke and Turetsky 2006, entire; Soja *et al.* 2007, entire; Pierce *et al.* 2008, entire; Flannigan *et al.* 2009, entire; Krawchuk *et al.* 2009, entire; Le Goff *et al.* 2009, entire; Bergeron *et al.* 2010, entire; Salathe *et al.* 2010, entire; Abatzoglou 2011, entire; McKelvey *et al.* 2011, entire; Abatzoglou and Kolden 2013, entire; Pederson *et al.* 2013, p. 1815; Price *et al.* 2013, pp. 342-343, 352-354; Barbero *et al.* 2014, entire; Trenberth *et al.* 2014, entire; Barbero *et al.* 2015, entire; Jolly *et al.* 2015, entire; Lute *et al.* 2015, entire; USEPA 2015, entire; Lienard *et al.* 2016, entire; Littell *et al.* 2016, entire; Westerling 2016, entire; see also section 3.2 above). Increases in fire frequency and size have the potential to adversely affect lynx and hare habitats in the DPS range by rapidly converting large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats (ILBT 2013, p. 70). Although this would likely be a temporary impact, with burned areas subsequently regenerating into higher-quality habitat, it would likely reduce landscape-level hare densities and therefore lynx numbers, potentially compromising an area's ability to support a resident lynx population until burned habitats recover.

Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already naturally marginal in many parts of the DPS range, it is possible that very large wildfires or many fires over a short time period could, perhaps in concert with other influencing factors, cause a shift in habitats in a given area from just barely capable of supporting a resident lynx population to no longer capable of doing so, resulting in extirpation. For example, as described in sections 2.3.2.2 and 4.2.4, large fires in Unit 4 during the past few decades have burned over a third of lynx habitat (Lewis 2016, pp. 4-6), increasing lynx home range size and reducing carrying capacity (Maletzke *in* Lynx SSA 2016, p. 21). If additional large fires occur in this unit before previously burned areas recover (10-40 years post-burn), carrying capacity and the lynx population would likely decline, further reducing the likelihood that resident lynx will persist (Lewis 2016, pp. 5-6; Lynx SSA Team 2016a, p. 44; also see sections 4.2.4 and 5.2.4). The loss of habitat resulting from these fires and its potential demographic impacts on the State's only resident lynx population contributed substantially to the WADFW's recent recommendation, and the State Fish and Wildlife Commission's decision, to uplist lynx from threatened to endangered under its State Endangered Species Program (Lewis 2016, entire; WAFWC 2016, p.3).

Wildfire frequency, size, and intensity have also increased in the Northwestern Montana/ Northeastern Idaho geographic unit, where about 4,172 km^2 (1,611 mi^2; over 15 percent of the unit) have burned in western Montana from 2000-2013 (Squires *in* Lynx SSA Team 2016a, p. 20). Large fires have also impacted lynx habitat in the Western Colorado geographic unit, where fire size, frequency, and intensity are expected to increase with climate change (Ivan *in* Lynx SSA Team 2016a, p. 23). As mentioned in section 2.3.2.2, large areas of the GYA unit were burned by the extensive wildfires of 1988. The extent to which those fires may have diminished lynx and hare habitats and contributed to the recent absence of resident lynx is uncertain, as is the potential for those burned areas to support high hare densities and resident lynx in the future. However, some burned areas may soon develop the dense horizontal conifer structure

favorable for hares and therefore for lynx foraging habitat, perhaps increasing the likelihood that they may support resident lynx in the near future.

Fire suppression was in the past thought to be a potential risk factor for lynx in the DPS range. However, given the trends discussed above and the likely continued increase in future fire activity related to projected continued climate warming, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of lynx populations, especially in places already affected by increased fire activity and those that are naturally only marginally capable of supporting resident lynx.

3.5 Habitat Loss and Fragmentation

Habitat loss for lynx is, generally, the conversion of boreal forest to another land use or vegetative cover. Fragmentation, which may involve permanent or temporary habitat loss, has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991; ILBT 2013, p. 76). "Patchiness" is sometimes used to refer to natural processes (Buskirk *et al.* 2000a, p. 85), whereas "fragmentation" refers to anthropogenic disruption of natural patterns. Boreal forest habitats in most parts of the DPS range are naturally patchy (ILBT 2013, p. 76) and marginal for both snowshoe hares and lynx compared to the northern cores of both species' ranges. In the northern contiguous United States, boreal forest transitions to various types of northern hardwood forest in the Northeast and Great Lakes Region and to drier, more temperate montane forests in the West. The transitional nature of the boreal forest at its southern extent is believed (along with competition from other hare predators) to limit the numbers of both hares and lynx, preventing either from achieving densities comparable to those regularly achieved (except during the low of the hare population cycle) in the classic boreal forests in the cores of both species' ranges in Canada and Alaska (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990a, p. 849; Koehler and Aubry 1994, p. 84; 79 FR 54790).

Forest loss and fragmentation are relatively low in the DPS range compared to other forested regions in the United States (Heilman *et al.* 2002, p. 416). Since 2000 in the western United States, land uses associated with residential development, roads, and highway traffic have resulted in a 4.5 percent (20,000 km^2 [7,722 mi^2]) loss in forest area, and continued expansion of residential development will likely reduce forested patches by another 1.2 percent percent by 2030 (Theobold *et al.* 2011, entire). Human-caused fragmentation in the forested western landscape resulted in a decline of weighted mean patch size from roughly 35,000 km^2 (13,514 mi^2) to 3,200 km^2 (1,236 mi^2) from natural to current conditions, but models predict relatively small declines in the size of forested patches over the next 30 years (Theobold *et al.* 2011, p. 2451). In the eastern United States, nearly half or more of the natural forest was cleared in the past 3 centuries, but as agriculture and settlement relocated westward and some eastern farmlands were abandoned, eastern forest cover rebounded (Williams 1989; Smith *et al.* 2005). Similarly, a large portion of Minnesota's forests was cleared in the last century and, although overall forest cover has rebounded, the forested area in northern Minnesota has decreased 4 percent since 1977 (Miles *et al.* 2007, p. 22). Future trends portend increased human population

and declining forestland in the United States (Haynes 2003), but whether and to what extent forest conversion will affect boreal forest habitat in the DPS is uncertain.

Effects of Fragmentation - Canada lynx seem to be flexible in their response to habitat fragmentation, whereas closely related species, such as bobcats and Iberian lynx, are sensitive to habitat fragmentation (Ferreras 2001; Crooks 2002). In southern Ontario, Hornseth *et al.* (2014, pp. 8-9) demonstrated that lynx exhibited a wide range of responses to habitat alteration. In general, lynx responded most positively to areas having greater than 50 percent suitable habitat and generally avoided areas having less than 30 percent suitable habitat. However, lynx showed no sensitivity to the degree of forest fragmentation in areas of high or low suitable habitat.

In the DPS range, lynx achieve highest densities in landscapes having a high percentage of large, contiguous patches of high-quality hare habitat (Simons 2009; Simons-Legaard *et al.* 2013). Throughout the DPS range, landscapes with more contiguous boreal forest habitat support more snowshoe hares than fragmented landscapes, and lynx select habitats that improve their foraging opportunities (Moen *et al.* 2008; Vashon *et al.* 2008a; Simons 2009; Fuller and Harrison 2010; Squires *et al.* 2010; Lewis *et al.* 2011, p. 565; ILBT 2013, p. 77). During winter, coarse-scale habitat selection by lynx in Maine maximized their access to snowshoe hares (Fuller and Harrison 2010; ILBT 2013, p. 77). In Montana, lynx similarly selected habitat patches that supported snowshoe hares and in winter avoided recent clearcuts or other open patches (Squires *et al.* 2010; ILBT 2013, p. 77). Several other studies documented lynx avoidance of large openings, especially during winter, probably because such habitats are rarely used by hares and would not, therefore, attract foraging lynx (Koehler 1990a; Mowat *et al.* 2000; von Kienast 2003; Maletzke 2004; Squires and Ruggiero 2007; ILBT 2013, p. 77). Koehler (1990a) suggested that lynx movements and habitat use patterns could be altered temporarily by vegetation management that creates large distances (> 100 m [328 ft]) to forested cover (ILBT 2013, p. 77).

Throughout the northern part of their range, snowshoe hares are found in vast areas of boreal forest interspersed with occasional bogs and fens and water that are less preferred. Conversely, southern hare populations (including most in the DPS range) occur primarily in insular patches of suitable habitat set amidst large areas of less-preferred habitats (Wolff 1980; Keith *et al.* 1993). This disparity has led a number of biologists to speculate that habitat fragmentation ultimately may be responsible for the non-cycling nature of snowshoe hare populations in southern Canada and the northern contiguous United States (Dolbeer and Clark 1975; Buehler and Keith 1982; Keith *et al.* 1993; Strohm and Tyson 2009). Wolff (1980, 1981) described the mechanism by which a fragmented habitat might dampen or eliminate cyclic population fluctuations. The patchy distribution and generally lower densities of hares in many parts of the contiguous United States require lynx in most areas of the DPS range to maintain larger home ranges than lynx in the core of the species' range (Mowat *et al.* 2000, pp. 265, 277–278). Larger home ranges likely require more energy output associated with greater foraging effort to acquire adequate food (Apps 2000, p. 364) and may expose lynx to increased risk of predation and

other mortality factors such as roads and trapping. At some point, landscape hare densities become too low, making some areas incapable of supporting lynx.

Snow, also an important component of lynx habitat (79 FR 54809), can be patchily-distributed, variable and unpredictable from year to year, and affected by local topography, water bodies, and climate gradients. Snow depth (Hoving *et al.* 2005; Peers *et al.* 2013, entire) and persistence (Gonzalez *et al.* 2007) are believed to give lynx a competitive advantage over generalist predators in the contiguous United States. The snow environment in much of the DPS range is patchy and marginal in both space and time for snowshoe hares and lynx. Too little snow or crusting conditions may favor potential competitors and predators like bobcat, fisher, and coyotes. High elevations may provide snow conditions that favor lynx, whereas lower elevations may favor conditions for competitors. Snow conditions that provide lynx a competitive advantage over other terrestrial hare predators are most consistent in the high-elevation regions of the western United States, although snow alone does not constitute lynx habitat (i.e., many places receive sufficient snow but lack other features lynx need, typically adequate hare densities). Lynx likely have a competitive advantage at higher elevations in the DPS in the winter, but not in summer months when potential competitors have increased access to all habitats. Snow conditions are less consistent in the East. For example, lake-effect snow from Lake Superior can increase snow depth and duration in northeastern Minnesota in some years but not in others. The Gulf of Maine has the reverse effect, and its warming influence reduces snow depth and duration inland. Distribution models by Hoving (2001, p. 74) indicate that eastern Maine has extensive areas of boreal forest, but they do not achieve snowfall conditions associated with lynx presence in other parts of the state, and lynx are rarely found there.

Naturally patchy forests and those fragmented by humans may exacerbate competition between lynx and other predators (Buskirk *et al.* 2000a, entire). Forest patchiness, fragmentation, and competition are strongly linked because vegetation mosaics in landscapes provide high-quality environments for generalist species such as the bobcat, red fox, and coyote (Goodrich and Buskirk 1995; Buskirk *et al.* 2000a, p. 84), and generalist predators tend to dominate the predator guild in patchy or fragmented landscapes (Oehler and Litvaitis 1996). Hares fluctuate less dramatically in the southern part of the lynx range, thus there is more competition for a limited resource and exploitation competition could be inflicted by generalists (e.g., coyotes) and other predators (Buskirk *et al.* 2000a, p. 95). Snowshoe hares in the south are concentrated in isolated patches of suitable habitat and subject to predation by a suite of generalist predators (e.g., Litvaitis *et al.* 1985; Sievert and Keith 1985; Keith *et al.* 1993; Cox *et al.* 1997). Keith *et al.* (1993) found that an extremely high predation rate on hares living in high-quality habitats seemed to be driving the changes in distribution and abundance in a snowshoe hare population in Wisconsin, rather than predation on naturally dispersing individuals. In that study, predation pressure on hare populations occupying small (< 7 ha [< 17 ac]) patches of preferred habitat was so severe that 3 of the 5 populations under investigation were extirpated in the course of the 3-year study. Fragmentation exacerbates the effect of predation by allowing carnivores to concentrate their hunting efforts on small patches of habitat used by their preferred prey instead of preying disproportionately on dispersing individuals (Wirsing *et al.* 2002, p. 170). In predator-

rich landscapes characteristic of the DPS, this can result in intense predation and competition for a limited prey resource.

Landscape features further fragment hare and lynx habitat. In the western geographic units, potentially suitable boreal forests and appropriate snow conditions occur in relatively narrow elevational bands in the Cascade and Northern and Southern Rocky Mountains (McKelvey *et al*. 2000a, pp. 243-246). Thus, lynx habitats are naturally fragmented by topography and vegetation gradients. These "islands" of habitat can be extensive (e.g., the Okanagan in Washington or most of northwestern Montana) or smaller and relatively isolated (e.g., the Garnet Range in western Montana) depending on topography and precipitation patterns. Some of these areas of boreal forest are separated by unsuitable habitats in the low valleys (e.g., sage flats, urban corridors, agricultural lands) or by snow regimes (e.g. snow shadows) that may discourage lynx dispersal between habitat patches (although verifed records of lynx in many parts of the contiguous United States and long-distance dispersal of lynx released in Colorado demonstrate that lynx at least occasionally navigate such habitats). In some western parts of the DPS range, lynx habitat is also fragmented by rugged, high elevation terrain (Carroll *et al.* 2001, p. 976). In most areas of the DPS, including Maine and Minnesota where there is little topography, lynx travel through a "matrix" of less suitable forested areas as they move between areas of higher-quality habitat. Large rivers are unlikely to fragment habitat as lynx readily swim across large bodies of water (Feierabend and Kielland 2014, entire) or cross them on ice in the winter (Koen *et al.* 2015).

As described above, both lynx and hares are influenced by the spatial arrangement of preferred habitat. Lynx populations are clearly most viable in areas having extensive and relatively unfragmented boreal forest habitats with large patches of high-quality foraging (hare) habitat and persistent deep, unconsolidated snow. Similarly, individual lynx have the smallest home ranges and greatest survival and productivity in landscapes that have extensive, large patches of habitat in combination with deep, fluffy snow. The factors described above create a naturally patchy distribution of high-quality lynx habitat thoughout much of the DPS range, resulting in generally lower reproductive output and a more tenuous conservation status for lynx in many parts of the DPS relative to those in Canada and Alaska (Buskirk *et al.* 2000a, p. 95). Thus, human activities, described below, that increase boreal forest fragmentation may further reduce the quality of lynx habitat that is already naturally marginal thoughout much of the DPS range, perhaps reducing the likelihood that resident lynx populations will persist.

Anthropogenic Sources of Fragmentation - Human activities can exacerbate the naturally-patchy habitat that is typical throughout much of the DPS range. Anthropogenic activities such as forest management, development, and highways alter natural landscape patterns. They cumulatively can reduce the total area of habitat, diminish the quality of habitat, increase the isolation of habitat patches, and impair the ability of lynx and other wildlife to effectively move between patches of habitat. Anthropogenic fragmentation may be permanent, for example by converting forest habitat to residential, industrial, or agricultural purposes, or temporary, for example by conducting forest management but allowing trees and shrubs to regrow. Habitat

fragmentation (both natural and anthropogenic) increases the risk of extirpation of small lynx populations.

Human-caused fragmentation of the already naturally patchy pattern of lynx habitat in the contiguous United States can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. Maintaining a mosaic of large (> 40 ha [100 ac]) patches of young to old stands in patterns that are representative of natural ecological processes and disturbance regimes would be conducive to long-term conservation of lynx (ILBT 2013, p. 77).

Roads, development, climate change, and forest management fragment snowshoe hare and lynx habitat in the DPS. We know little about how hare and lynx respond to these anthropomorphic changes to their habitat, which requires additional research (Murray *et al.* 2008, p. 1464; Squires *et al.* 2013, p. 194). In the next decades, southern lynx populations will likely incur further habitat loss and fragmentation from these and other factors. Changes in habitat, prey base, and perhaps competitor guild will likely impact lynx populations in the DPS and in southern Canada.

Roads - Paved highways fragment lynx habitat. They surround large areas of lynx habitat in Minnesota and northern Maine. In the West, they typically follow natural features such as rivers, valleys, and mountain passes that may have high value for lynx in providing habitat or connectivity. Nonetheless, the density of paved roads is generally low in most lynx habitat in the DPS range. Various studies have documented lynx crossing highways. A male lynx in western Wyoming was documented to have successfully crossed several 2-lane highways during exploratory movements (Squires and Oakleaf 2005). However, in Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx (Bayne *et al.* 2008). Apps *et al.* (2007) found lynx were 13 times less likely to cross the Trans-Canada Highway (a 4-lane highway) relative to random expectation, but only 2.2 and 3.1 times less likely to cross smaller 2-lane highways (93 and 1A, respectively). In southeastern British Columbia, lynx avoided crossing highways within their home ranges (Apps, 2000). Squires *et al.* 2013 (p. 194) documented 44 radio-collared lynx with home ranges within an 8 km buffer of 2-lane highways; however, only 12 of these individuals crossed the highway. Paved highways also pose a risk of direct mortality to lynx and may inhibit lynx movement between previously connected habitats. If lynx avoid crossing some highways, this could lead to a loss of effective habitat within a home range and reduced interaction within a local population (Apps *et al.* 2007). Lynx and other carnivores may avoid using habitat adjacent to highways, or become intimidated by highway traffic when attempting to cross (Gibeau and Heuer 1996; Forman and Alexander 1998).

Carnivores are especially vulnerable to highway-caused mortality in areas with dense and high traffic volume roadways (Clevenger *et al.* 2001). As the standard of roads increases from single-lane gravel to 2-lane or 4-lane highways, traffic volumes and the degree of impact are expected to increase. Walpole *et al.* (2012, p. 770) found that small logging roads with low traffic volume had no effect on lynx distribution, and lynx in Nova Scotia followed road edges for considerable distances (Parker 1981, p. 229). In Maine, lynx occasionally travel on unplowed logging roads during winter, but these roads and their associated edge habitat were selected against within home ranges (Fuller *et al*. 2007, p. 1983). Lynx killed fewer hares near logging roads in Maine likely because hare density was lower there than in adjacent un-roaded habitats (Fuller *et al*. 2007, p. 1985; Fuller and Harrison 2010, p. 1274) or possibly because of increased potential for interactions with generalist competitors suchs as coyotes (Fuller *et al*. 2007, p. 1985). In Minnesota, Moen *et al*. (2010b) found that lynx selected for roads during long-distance movements. Although roads may not be essential to these movements, lynx appeared to benefit energetically from the use of these linear features. Squires *et al*. (2008) reported that lynx denned farther from all roads compared to random expectation.

Four-lane highways, such as the interstate highway system, commonly have fences on both sides, service roads, parallel railroads or power lines, and impediments like "Jersey barriers" that make successful crossing more difficult, or impossible, for wildlife (ILBT 2013, p. 78). Alexander *et al.* (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. In Colorado, lynx successfully and repeatedly crossed major highways, including I-70 (Ivan 2011c; 2011d; 2012). Colorado lynx crossed 2-lane highways an average of 0.6 times per day and more frequently during dusk and at night when traffic volume was lower (Baigas *et al.* 2017, p. 204). They also crossed 4-lane highways (I-70), especially in forested areas under large, elevated bridges that spanned streams (Baigas *et al.* 2017, p. 204).

Between 2000 and 2015, 54 lynx were reported to have been killed on roads (both paved and unpaved) in Maine (Vashon, MDIFW, *unpubl. data*), 9 in Minnesota (and 2 hit by trains; USFWS 2016b, *unpubl. data*), 1 in Idaho, and 5 in Montana (USFWS 2016c, *unpubl. data*). Between 1995 and 2011, 15 lynx were reported killed on British Columbia highways (British Columbia Wildlife Accident Reporting System 2012, as cited in ILBT 2013, p. 78). Most of these mortalities are on higher-speed paved highways. However, in Maine, about 41 percent (22 of 54) were killed on dirt logging roads with low traffic volumes and lower speed limits. In Minnesota, 2 lynx were killed on backcountry railroads and 2 on unpaved forest roads. Backcountry roads also provide human access into lynx habitat where incidental trapping or illegal shooting can occur.

Translocated lynx may be more vulnerable to road mortality than resident lynx (Brocke *et al.* 1991, p. 308), because they often move extensively after their release and are unfamiliar with their surroundings (ILBT 2013, p. 78). In the Adirondack Mountains of New York, an attempt to reintroduce lynx failed and 18 of 37 documented mortalities (among 83 lynx released over 3 years; Brocke *et al*. 1993, p. 1) were attributed to road kills (Brocke *et al.* 1991, p. 308; ILBT 2013, p. 78). Over a 7-year period in Colorado, 13 of 102 documented mortalities of translocated lynx were the result of vehicle collisions on highways (Devineau *et al.* 2010, p.

528). Traffic volumes on those Colorado highways were estimated to range from about 2,300 to > 25,000 vehicles per day (USFWS 2016c, *unpubl. data*, p. 1).

In summary, roads of all sizes may have direct (e.g., habitat loss and fragmentation, vehicle collisions) as well as indirect effects to lynx. The latter may include increasing human access, potentially resulting in increased incidental trapping and illegal shooting; creating edge habitats that may promote co-occurrence with potential competitors like coyotes and bobcats (Bayne *et al.* 2008, p. 1195); reducing prey densities; and influencing lynx behavior, both detrimentally (avoidance) and beneficially (energetic savings during long-distance movements). Although potential adverse impacts of roads in lynx habitats likely outweigh any potential benefits, thus far population-level impacts of roads have not been demonstrated among DPS lynx populations.

Vegetation Management - As described above in section 3.3, forest management can further fragment boreal forest in the northern contiguous United States, potentially affecting habitat suitability for both snowshoe hares and lynx. Large-scale forest fragmentation or maturation can be detrimental to snowshoe hares because both can cause hares to become increasingly restricted to remaining small patches with adequate cover, where higher predation rates from a variety of carnivores tend to increase local hare extinction risk (Wolff 1981; Keith *et al.* 1993; Wirsing *et al.* 2002; see also Barbour and Litvaitis 1993, entire). Although forest management can benefit lynx if it creates, maintains, or restores a shifting mosaic of high-quality habitat, it can also be detrimental if it fragments habitat into small, widely-spaced parcels. Changes to vegetation structure can influence lynx movements; in Montana, fragmentation from forest thinning decreased the probability of lynx movements across the forested landscape (Squires *et al.* 2013, p. 192). Lynx in the Northern Rockies also seem sensitive to changes in forest structure and avoid large forest openings like recent clearcuts and thinned areas, particularly in winter (Koehler, 1990a; Squires *et al.* 2010). Modeling in Maine suggests that the shift from clear-cutting to partial harvesting will likely increase the number of patches of high-quality hare habitat but greatly reduce the size of patches and increase their isolation (Simons-Legaard *et al.* 2016, pp. 5-6), thus diminishing landscape habitat quality for lynx. See section 3.3 for further discussion of vegetation management as a potential source of habitat fragmentation.

Residential and Commercial Development - Residential and commercial development is increasing on private forest lands. Increased traffic and urbanization are projected for the Northern Rockies (Hansen *et al.* 2002) and Maine (also see section 5.2.1). It is uncertain to what degree lynx can tolerate habitat fragmentation from roads and clearing forest for development, and how human and pet activity associated with development may affect lynx use of habitats. Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat *et al.* 2000). The degree to which residential development and associated roads reduce connectivity of mesocarnivore populations (including lynx) likely depends on the physical design of highway improvements, the surrounding environmental features, the density of increased urbanization, and the increased traffic volume (Clevenger and Waltho, 2005; Grilo *et al.* 2009).

Ski area development also results in permanent habitat loss and fragmentation. One ski run is often separated from the next only by small inter-trail forest islands. Ski runs often are intermixed with other open areas such as open or gladed bowls, rock outcrops, or barren tundra ridges. Ski resorts that are built or expanded in lynx habitat may impact lynx by removing forest cover, reducing the snowshoe hare prey base, and creating or increasing human disturbance in or near linkage areas. There is limited information on lynx behavior and habitat use in and around ski areas. Lynx have been known to incorporate smaller ski resorts within their home ranges, but may not utilize the large resorts. Preliminary information from an ongoing study in Colorado suggests that some recreational use may be compatible, but lynx may avoid some areas with concentrated recreation use. In some areas, lynx habitat may be limited and concentrated in the ski area development footprint (ILBT 2013, p. 55). More than 50 ski areas exist throughout the range of the lynx in the contiguous United States (ILBT 2013, pp. 82-83). Most ski areas are located on north-facing slopes, where ample snow conditions provide for extended ski/snowboard recreational seasons. In the western states, many of these landscapes feature spruce-fir forests. While ski resorts occupy a small proportion of the landscape, spruce-fir forests provide important habitat for snowshoe hares and lynx at the southern extent of their range. In winter, alpine and Nordic skiing and snowboarding are the primary uses. Most of these resorts offer year-round recreation, with summer activities typically including hiking and mountain biking. Despite concerns regarding ski-area impacts to lynx, they have affected only a tiny fraction of potential lynx habitats in the DPS range, and no population-level effects of ski areas or related recreation activities have been demonstrated for DPS lynx populations.

Mineral Extraction – Mining and oil and gas exploration and production activities occur primarily within the western units of the DPS although there is increased interest in mining in the Minnesota and Maine units. Lynx habitats may be lost and fragmented as a result of mining, similar to other development: loss of boreal forest; construction of roads, railroads, and transmission lines; and increased human access and disturbance where lynx occur. In the West, for example in the Wyoming Range (Unit 5), extensive oil and coal bed methane development can affect large areas of landscape (e.g., 1 well per 2-4 ha (5-10 ac) and could diminish potential lynx habitat in some areas. Open pit and subsurface mines can affect from tens to thousands of hectares of habitat. To reduce effects of mineral development, land exchanges are sometimes implemented to consolidate private land ownership of the surface above a deposit to be mined. Depending on the lands exchanged, this could retain lynx habitat in public ownership. Surface deposits of minerals and gravel for forest road construction are excavated within some lynx areas and vary from a single truck load to tens of acres. Although mining and oil and gas development can result in loss and fragmentation of lynx habitats, thus far, effects to DPS lynx populations have not been demonstrated.

Wind Energy - Wind energy development and associated transmission lines are increasing across the nation and could affect lynx habitats. Facilities are often located on ridge tops or other areas exposed to consistent wind. Construction of wind facilities, including access roads, clearing for turbines, and transmission lines, may result in loss of lynx habitat and increased fragmentation from permanent forest clearings. Noise and human activity associated with the construction and operation of wind facilities could disturb or displace lynx from important

habitats. Effects would likely continue through the life of the project, which may exceed 20 years. Wind energy development has occured in some areas of the lynx DPS but has effected relatively small amounts of lynx habitat. Despite being a potential source of additional habitat loss and fragmentation, there is no information to suggest that wind energy development has had population-level effects on lynx in the DPS range.

Utility Corridors - Utility corridors contain developments such as overhead or buried powerlines and gas pipelines, and often are located within or adjacent to existing road rights-of-way. Utility corridors potentially could have short- or long-term impacts to lynx habitats, depending on location, type, vegetation clearing standards, and frequency of maintenance. Those that are extensively cleared of vegetation and maintained in grass or herbaceous vegetation likely equate to a permanent habitat loss. When associated with highways and railroads, utility corridors may further widen rights-of-way. Utility corridors can facilitate human access into previously remote areas potentially exposing lynx to increased trapping, illegal shooting, or other human disturbance. In most instances, naturally-vegetated utility corridors are less than 300 m (984 ft) wide and would not be expected to block lynx movements. Despite being a potential source of additional habitat loss and fragmentation, there is no information to suggest that impacts from utilitiy corridors have had population-level effects on lynx in the DPS range.

Agriculture - Agricultural activity currently is not expanding in lynx habitat areas and has decreased in some parts of the DPS range. For example, the amount of farmland in northern Maine has declined by over 75 percent, from over 1.2 million ha (3 million ac) in the late 1800s, to about 283,000 ha (700,000 ac) early this century (Ahn *et al.* 2002, p. 8). Most of the current farming is in northeastern Maine, where it fragments the forested landscape corridor between core habitats in northern Maine and western New Brunswick. However, lynx have been documented dispersing through this landscape (J. Vashon, Maine Department of Inland Fisheries and Wildlife, *unpubl. data*). Forest clearing for agriculture also may have contributed (along with increasing road densities and an expansion in coyote distribution) to the recent contraction in the southern part of lynx range in eastern Alberta (Bayne *et al.* 2008, p. 1195). Overall, agricultural activities occur at very low levels within potential lynx habitats in the DPS range, and no impacts to DPS lynx populations have been demonstrated.

Habitat Loss and Fragmentation in Corridor Areas Connecting Lynx Populations in the DPS with Adjacent Populations in Canada - Lynx conservation in the contiguous United States is thought to depend in part on maintaining connectivity with habitat areas and lynx populations in Canada. Maintaining connectivity for lynx may become increasingly difficult because of climate change and other anthropogenic influences, as evidenced by reduced connectivity for other boreal species (van Oort *et al.* 2011). Potential corridors have been identified in the northern Rockies (Squires *et al.* 2013, entire). There are likely broad forested corridors with suitable dispersal habitat connecting core habitats in Maine to southern Quebec and northern New Brunswick, and northern Minnesota to southern Ontario. Given the perceived importance of lynx immigration from Canada to the persistence of the DPS (FR 68 40076– 40101; Squires *et al.* 2013, p. 187), roads and other forms of habitat loss and fragmentation that may impede lynx movements in the border regions of Canada and the United States are of concern.

Summary - Although lynx responses to forest management and forest roads are relatively well understood (e.g., Simons-Legaard *et al*. 2016, entire; sections above), their response to other human activity and types of development remain poorly understood. Nearly all studies of lynx in North America occurred in remote areas where human activity and development are minimal. In more developed areas of the DPS range, lynx may have to balance selection for prey density against mortality risk from humans. For example, in a developed landscape in Norway, Eurasian lynx demonstrated a trade-off in habitat selection, avoiding areas near human development despite high prey (roe deer, *Capreolus capreolus*) densities, and instead selecting areas with intermediate prey abundance and lower levels of human disturbance (Basille *et al*. 2009, pp. 687-690). Their occurrence in areas having intermediate human occupancy (Basille *et al*. 2009, p. 687) confirms their ability to live in relatively human-modified habitats. Because lynx and snowshoe hares in North America are not typically associated with human development, it is uncertain whether Canada lynx would make similar trade-offs between prey density and risks associated human activity.

Overall, most lynx habitats in the DPS range are naturally fragmented, which limits the abundance and density of both hares and lynx. The largest source of anthropogenic fragmentation throughout the DPS range is vegetation management (timber harvest and related silvicultural treatments), which has thus far benefitted lynx in northern Maine by creating optimal hare (and thus lynx foraging) habitat. In other geographic units, there have likely been localized adverse (and potentially some beneficial) impacts of vegetation management to lynx habitats and perhaps individual lynx. However, we find no evidence that habitat loss and fragmentation from forest management or other anthropogenic activites have had population-level negative consequences for resident lynx in the DPS range or resulted in extirpation of lynx from areas that previously supported persistent resident populations. That said, many parts of the DPS range seem naturally only marginally capable of supporting resident lynx populations, and it is possible that relatively low levels of anthropogenic habitat loss and fragmentation, in addition to natural fragmentation, could diminish landscape-level hare densities to the point that resident lynx populations may be unable to persist.

Chapter 4: Current Conditions

In this chapter, we present our understanding, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the current status of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the current conditions in each geographic unit, followed by a more detailed evaluation of the status of lynx populations and habitats and the factors currently believed to influence them in each unit. Where appropriate, we compare our current understanding to what was known or believed when the DPS was listed under the ESA in 2000 and to our understanding of historical conditions.

4.1 Summary of Current Conditions DPS-wide

Because of the limitations and uncertainty in the historical records of lynx occurrence in the contiguous United States (described above in section 2.3.2.1), it is difficult to compare the current distribution and status of resident lynx populations in the DPS with what may have been the historical condition (but see evaluation in section 2.3.2.2). However, research and surveys over the last 2 decades have significantly improved our understanding of the current distribution, habitats, and the status of resident populations compared to what was known when the DPS was listed in 2000. For example, although we knew there were some resident lynx in Maine (Unit 1), we lacked information on the quality and distribution of lynx and hare habitats and the potential number of lynx. We now know this unit currently has large areas of high-quality habitat created by the regeneration of areas of extensive clear-cutting in the 1970s and 1980s in response to a large spruce budworm outbreak, that there are probably more lynx in Maine now than was likely under historical natural disturbance regimes and habitat distributions, and that currently this unit probably supports the largest resident lynx population in the DPS. Similarly, when the DPS was listed, we were uncertain whether Minnesota (Unit 2) supported a resident population. We now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western United States (Units 3, 4, 5, and 6) are naturally less abundant and more patchily-distributed than was thought at the time of listing, and several areas thought to have historically supported small resident populations currently do not (the GYA [Unit 5], the Garnet Mountains in western Montana [Unit 3], and the Kettle Mountains of northeastern Washington). We also know that recent extensive wildfires in north-central Washington (Unit 4) have substantially reduced (probably temporarily) the amount of high-quality lynx habitat and likely caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999-2006 and the subsequent survival and reproduction of some of these lynx and some of their offspring, resident lynx currently occupy parts of western Colorado (Unit 6), although the current number of lynx there is uncertain.

With regard to redundancy, defined as the ability of the DPS to withstand catastrophic events, we find that the current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a single catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southern Colorado. Resident breeding lynx populations currently occupy 5 of the 6 geographic units (all but the GYA; fig. 1). Of the 5 occupied units, 4 are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2; see tables 2 and 3). Our analyses and lynx expert imput indicate no single catastrophic event that could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS and, further, no or a very low likelihood of functional extirpation of any of the individual geographic units caused by a single catastrophic event (Lynx SSA Team 2016a, p. 56).

Because we lack evidence that resident lynx populations have been lost from any other large geographic areas in the contiguous United States, it also seems that redundancy in the DPS

has not been meaningfully diminished from historical levels. That is, the loss of resident lynx populations in the DPS, to the extent suggested by verified historical records, was likely in areas peripheral to the geographic units that currently support resident lynx (e.g., northern New Hampshire [McKelvey *et al*. 2000a, pp. 212-214], the Kettle/Wedge area of northeastern Washington [Koehler et al. 2008, p. 1523; Lewis 2016, pp. 1-2], Isle Royale in Lake Superior [Licht *et al*. 2015, entire]). Any small populations that were lost were not in large, discrete geographic units that would have represented substantially greater redundancy in the contiguous United States. The implications of the potential recent loss of resident lynx in the GYA for the redundancy of the DPS are unclear. The historical record and recent research show that the GYA has supported resident lynx. However, it is unclear whether the area consistently supported a resident breeding population over time or whether it naturally supported resident lynx only some of the time ("winked on" in a metapopulation sense) when habitat conditions and hare densities were favorable, and at other times, when habitats and hare densities were less favorable, it did not support resident lynx ("winked off" in a metapopulation sense). Given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton national parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. If so, the contribution of the GYA to redundancy within the DPS is questionable.

Representation, defined as the ability of the DPS to adapt to changing environmental conditions, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016a, p. 25). Lynx experts and geneticists indicated high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016a, pp. 12-14, 55-56). Although hybridization with bobcats has been documented in the DPS (in Maine and Minnesota), it is not considered a substantial current threat to the DPS (Lynx SSA Team 2016a, p. 13). Further, despite differences in forest community types and other habitat parameters (e.g., topography and elevations) lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Therefore, lynx likely have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or primary prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous United States. Because there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, we find that the current level of representation does not appear to represent a decrease from historical conditions.

Resiliency, the ability to withstand stochastic disturbance events, is currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. However, because we lack reliable estimates of the sizes and trends of most lynx populations in the DPS, we are unable to use these parameters to evaluate

the current resiliency of individual populations or geographic units. Although some demographic data (survival, reproductive rates) are available for each geographic unit (see table 4), they were collected using different methods, at different times, and for different intervals, and possibly at different points in hare population cycles or fluctuations and, therefore, do not provide a consistent measure of resiliency. Efforts to understand resiliency within the DPS are also confounded by the metapopulation structure thought to govern lynx populations at the southern margin of their continental range, which suggests that some populations may be naturally ephemeral (i.e., “winked on” when conditions are favorable; “winked off” when conditions are not favorable). The related uncertainty about the extent to which DPS populations may rely on cyclic immigration of lynx from Canada during population irruptions and the ambiguity in the historical record that limits our understanding of the relative persistence of lynx in various geographical areas also limit our ability to characterize, rank, or model the relative contribution of each geographic area to the resiliency of the DPS.

Despite uncertainties and data deficiencies, qualitative factors provide some hints about current relative resiliency among some geographic areas or parts of them. For example, in Maine, lynx have demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the current apparent absence of resident lynx in the GYA (Unit 5) and in the Garnet Mountains of Unit 3 may indicate the lower level of resiliency expected among small and relatively more isolated populations. The persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population; however, the post-fires increase in home range size and likely decrease in lynx numbers may indicate the population is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Overall, the apparent long-term (historical and current) persistence of resident lynx populations in at least 4 of the 6 geographic units (Units 1-4), and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historical conditions, suggest historical and recent resiliency of lynx populations in the DPS.

In summary, the lynx DPS currently exhibits redundancy sufficient to preclude extirpation as a result of catastrophic events. The genetic health and ecological diversity expressed across the DPS range likewise suggest the recent and current maintenance of representation. The long-term persistence and broad geographical distribution of lynx populations in 4 of the 6 geographic units also suggests historical and recent resiliency in the DPS, although the potential recent extirpation of several small populations may be an indication of declining resiliency in those places.

4.1.1 Summaries of Current Conditions in Each Geographic Unit

Unit 1 - Northern Maine: This geographic unit encompasses the northern hardwood and spruce-fir (Acadian) forest in roughly the northern half of Maine. Resident lynx in this unit represent the southern periphery of a larger and highly resilient population (Harrison 2017, p. 3) that also occupies southern Quebec (where trapping is legal) and northern New Brunswick

(where lynx are a provincially-endangered species and harvest is prohibited). Although the actual number of resident lynx in this unit is unknown, the MDIFW believes this unit currently may be capable of supporting 750-1,000 lynx based on estimates of habitat distribution and lynx home range sizes (Vashon *et al*. 2012, pp. 87-91), which would make it the largest population in the DPS. This is many more resident lynx than likely occurred historically and many more than were suspected to occur in this unit when the DPS was listed, and it is the result of extensive clearcutting and herbicide application to salvage spruce-fir and encourage softwood regeneration following a severe spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004; Vashon *et al.* 2008b; Simons 2009, pp. 122-165). Those past treatments have created the current extensive distribution of young, regenerating softwood stands that provide optimal hare foraging habitat. Lynx responded to these conditions with high survival and reproduction, small home ranges, and the highest densities documented in the DPS. Historically, under a more natural disturbance regime, Maine typically had a greater proportion of mature forest and, therefore a patchier distribution of high-quality habitat that likely supported a smaller lynx population that may have been more dependent on immigration from Canada. State forestry regulations passed in 1989 caused landowners to shift to various forms of partial harvesting that have resulted in lower landscape hare densities across much of the unit. Hare populations do not seem to cycle in this region, but hare density estimates from 2008-2015 declined by over 50 percent compared to estimates from 2001-2006. Reproduction and adult survival declined in the low-hare environment after 2006, although kitten survival remained high. Unlike other DPS units, lynx habitat in northern Maine occurs nearly entirely on private, industrial forest lands, most of which lack long-term commitments to lynx management. The majority of private lands in this unit are now owned by investment companies seeking to diversify income from their investments, which could result in forest practices less likely to maintain or conserve hare and lynx habitat. Other potential stressors to lynx in this unit include incidental trapping, road mortality, large-scale wind energy development, residential and resort development, and parcelization of forestlands from rapid turnover in investment company landowners. Another spruce budworm outbreak may be imminent, and forestry response by investment landowners is uncertain. Climate change is a concern because average annual snowfall and duration are currently at the minimum thresholds believed necessary to give lynx a competitive advantage over bobcats and other mesocarnivores. Although lynx regularly occur outside this unit in southeastern and southwestern Maine, and small numbers of reproducing lynx have also been documented recently in northern New Hampshire and northern Vermont, the ability of some of these peripheral areas to support persistent breeding populations is questionable. However, recent telemetry data in Maine suggest that resident lynx are expanding both east and south of the Northern Maine Geographic Unit, with home range maintenance and reproduction documented in both areas, which previously were considered outside the area capable of supporting resident lynx (Vashon 2017, *pers. comm*.).

Unit 2 - Northeastern Minnesota: This geographic unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder (*Alnus* spp.) or willow (*Salix* spp.) shrub swamps, and black spruce (*Picea mariana*) or tamarack (*Larix laricina*) bogs. Despite uncertainty when the DPS was listed, it has become apparent that a reproducing resident population of roughly 50 to 200 lynx exists in northeastern Minnesota. This unit is directly

connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario, where trapping of lynx is legal. Lynx in Minnesota select regenerating forest dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites are associated with regenerating and mixed forest (Burdett 2008, p. 57). Hare densities in parts of northeastern Minnesota appear to be sufficient to support a viable lynx population and are highest in regenerating forests (McCann and Moen 2011, p. 513). The Superior National Forest continues to manage lynx habitats in accordance with its 2004 Forest Plan, which includes measures to minimize several risk factors and promote lynx conservation on the forest. Management of lynx habitat on State and private lands is voluntary and lacks long-term commitments to lynx management. Factors affecting current conditions in this unit primarily include forestry management, roads, and incidental trapping; other factors that could potentially impact resident lynx in this unit include mining development, snow compaction related to winter recreation, competition with bobcats, and lynx-bobcat hybridization. Since 2000, 45 lynx mortalities have been documented in Minnesota from unknown causes (16), incidental trapping (11), vehicle collisions (9 on roads and 2 on railroads), and illegal shooting (7). Six lynx radio-collared in Minnesota died after traveling north into Ontario, 4 from legal trapping/hunting, and 2 from unknown causes; some of these mortalities occurred years after the lynx was last located in Minnesota, indicating survival of Minnesota lynx in Ontario for extended periods is possible.

Unit 3 - Northwestern Montana/Northeastern Idaho: The historical and current sizes of the resident lynx population in this unit are unknown, but it is thought currently to be capable of supporting 200-300 lynx home ranges. Habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought when the DPS was listed (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016a, p. 12). Minor genetic differences suggest 3 subpopulations in the northwest (Purcell Mountains), central (Seeley Lake), and southern (Garnet Mountains) parts of the unit. No lynx were detected in the Garnet Range from 2011 to 2015, prompting concerns about the potential loss of the small resident population (perhaps 7-10 lynx) documented there in the mid-1980s and again recently from 2002 to 2010. However, whether this absence indicates the extirpation of a previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. A single lynx was verified in the Garnet Range in February 2016, indicating that natural recolonization of the area is possible; however, subsequent surveys have failed to detect that lynx or other lynx, and there currently remains no evidence of lynx residency in this mountain range (Lieberg 2017, *pers. comm.*). Most (about 90 percent) of this unit is managed to conserve and restore lynx and hare habitats, including on Federal, State, Tribal, and some private lands. Past timber harvest and associated management (e.g., thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx, with habitats in the Garnet Range being a possible exception (see 4.2.3 below). The size, frequency, and intensity of wildfires in this unit have increased over the past several decades, likely in response to climate warming, but population-level impacts to lynx have not been documented. Whether (and if so to what extent) other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit are also unknown. Regulations prohibit lynx

trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Hare densities have not been estimated broadly throughout the unit but appear to be low or marginal even in what is considered the highest-quality habitat, suggesting that even small decreases in habitat quality/hare densities could influence its continued ability to support resident lynx. The role of past and recent immigration in maintaining the demographic and genetic health of current lynx populations in this unit is unknown, but peaks in cyclic lynx numbers in Canada have declined, especially when compared to the unprecedented irruptions of the early 1960s and 1970s, and there is no evidence of significant immigration into this unit since then.

Unit 4 – North-central Washington: This geographic unit encompasses extensive boreal forest vegetation types and is directly connected to lynx habitats and populations in British Columbia. It represents about 58 percent of the Okanogan Lynx Mangagement Zone (LMZ) designated by the WADNR. Historical and current resident lynx numbers in northern Washington are unknown, but recent habitat and home range analyses for the larger Okanogan LMZ (summarized in Lewis 2016) suggest that this geographic unit may have been capable of supporting about 50 lynx prior to extensive wildfires over the past 2-3 decades (85-90 lynx in the entire LMZ). Those fires affected over a third of the LMZ, led to increased home range size, and may have reduced the carrying capacity of this unit to perhaps 30 lynx currently (50-55 in the entire LMZ). Additional extensive wildfire activity in the northern part of this unit in 2017 may result in further reduction of carrying capacity. The recent increases in wildfire frequency, size, and intensity in lynx habitat in this unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943). Burned habitats are expected to regenerate back into suitable lynx habitat, but this may take 10-40 years. However, additional wildfire activity in this unit before previously burned areas recover could substantially reduce the viability of the lynx population in this geographic unit (see section 5.2.4). Because of these habitat impacts and remaining stressors to lynx, the Washington Department of Fish and Wildlife recently submitted, and the State Fish and Wildlife Commission adopted, a proposal to uplist lynx from threatened to endangered within the State. Hare densities in Washington are generally at the low end of the range thought necessary to support lynx persistence. The Okanogan-Wenatchee and Colville National Forests, which administer more than 90 percent of lynx habitat in Washington, continue to manage in accordance with the LCAS. Additionally, the WADNR, which manages approximately 4 percent of lynx habitat in Washington, developed a Lynx Habitat Management Plan in 1996, which was updated in 2006 and is also largely based on the LCAS. The Kettle Range to the east of this unit was suspected to have supported a small (likely fewer than 20 individuals) resident population until about 30 years ago when over-trapping compounded by habitat changes may have resulted in its extirpation (Stinson 2001, p. 13; Koehler *et al.* 2008, p.1523). Potential impediments to lynx movement between the Kettle Range and the Cascades and British Columbia may make natural recolonization of the Kettle Range unlikely.

Unit 5 - Greater Yellowstone Area (GYA): There are no reliable estimates of current or historical lynx numbers in this unit but, given its naturally-fragmented potential habitat, generally low hare densities, and the paucity of verified records, it appears unlikely this unit ever supported a large resident population, and it is possible that this unit historically supported resident lynx only

ephemerally. No lynx have been verified in this unit since 2010, but whether this indicates the extirpation of a small but previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Over 97 percent of this unit consists of Federal lands that are currently managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx. The size and intensity of wildfires have increased over the past several decades, predominantly in the northern half of the unit (including the large fires of 1988 in Yellowstone National Park) and likely in response to climate warming, but impacts to lynx are uncertain. Whether (and if so to what extent) other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit are also unknown. Snow conditions currently appear to be adequate, with most of this geographic unit modeled to have a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12). Hare densities were very low in most of Yellowstone National Park but high in parts of the Bridger-Teton National Forest in the southern half of the unit. The role of past and recent immigration in maintaining the demographic and genetic health of lynx populations in this unit is unknown. This unit lacks direct connectivity to other lynx populations, and there is only anecdotal evidence that irruptions of lynx from Canada resulted historically in immigration into this unit. At least 9 lynx released in Colorado dispersed northward into this unit and some temporarily occupied home ranges in areas used previously by native resident lynx, but there is no evidence of long-term occupancy or reproduction by these lynx.

Unit 6 - Western Colorado: The current and historical numbers of resident lynx numbers in this unit are unknown, but CPW lynx biologists believe it currently could support 100-250 lynx as a result of the 1999-2006 release of 218 lynx from Canada and Alaska. Released lynx had high survival but the proportion of females producing kittens and kitten survival were low. This unit is not directly connected to lynx populations in Canada, and it does not appear to have received immigrant lynx during the historicaly large irruptions of the early 1960s and early 1970s. Since 1996, 2 unprecedentledly large bark beetle epidemics have affected about 16,200 km^2 (6,255 mi^2) of spruce-fir and lodgepole pine forests in Colorado, including much of the lynx habitat in this unit. Additionally, the 2013 West Fork Complex fire impacted more than 400 km^2 (154 mi^2) of lynx habitat in the San Juan Mountains. Beetle outbreaks do not appear to have negatively impacted hares, and hare numbers may increase in affected areas as succession progresses; however, they have negatively impacted red squirrels, an important alternate prey species for lynx in this unit. Areas affected by beetles that contained multi-story stand conditions likely continue to provide habitat to support snowshoe hares and lynx. Areas affected by fire may require 20 years or more, and in some areas considerably longer, to recover to a point where the stands will again support snowshoe hares. Large-scale monitoring efforts in the San Juans documented continued lynx occupancy during 2010-11, 2014-15, and 2015-2016, and it is reasonably likely that lynx continue to occur in all national forests within the State of Colorado. Snowshoe hare habitat is naturally patchily-distributed in this geographic unit, which limits hare abundance. Because the majority (90 percent) of potential lynx habitat in Colorado is under Federal land management, actions occurring on other ownerships are unlikely to result in significant impacts to lynx habitat within this unit. The USFS manages over 85 percent of the

lynx habitat in this unit, providing conservation through the SRLA. However, regulatory mechanisms for the conservation of lynx are lacking on approximately 3,159 km^2 (1,220 mi^2; over 12 percent) of this unit, including lynx habitats on some BLM and some non-Federal lands.

Table 4. Summary of current conditions in 6 geographic units within the DPS range[1].

	Unit 1 - Northern ME	Unit 2 - Northeastern MN	Unit 3 - Northwestern MT, Northeastern ID	Unit 4 - North-central WA	Unit 5 - Greater Yellowstone Area	Unit 6 - Western CO
Unit Size (km^2)	28,909	21,101	26,997	5,176	23,687	25,294
Percent of Unit in Conservation Ownership (i.e., Federal, State, Tribal, Other Conservation Org.)	10 - 15	75 - 90	> 95	> 90	> 95	> 90
Connectivity to Lynx Populations/ Habitats in Canada	Directly connected to lynx habitats/ populations in s. Quebec and n. New Brunswick; evidence of natural movement, but rates of immigration/ emigra ion unknown	Directly connected to lynx habitats/ populations in s. Ontario; evidence of natural movement, but rates of immigra ion/ emigration unknown	Directly connected to lynx habitats/ popula ions in s. Alberta and s. Bri ish Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	Direc ly connected to lynx habitats/ populations in s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	No direct connec ion; rates of immigration/ emigra ion unknown	No direct connection; rates of immigration/ emigration unknown; long-distance dispersal (emigration) documented to many western states and to Canada
Home Range Size (Adult Female, km^2)	25-33	17 - 21	43 - 115	37 - 91	50 (1 female, 3 years)	75
Productivity – Percent Females with Kittens	89% (high hares); 30% (low hares);	100%	83% (Purcells); 61% (Seeley Lake)	100% (2 females)	Few data	24%
Productivity - Litter Size	2.74 (high hares); 2 25 (low hares)	3.3	2.95 (Purcells); 2.24 (Seeley Lake)	2 25 (2 females)	3.0 (1 female, 2 years)	2.75
Average Annual Adult Survival Rate	0.80 (high hares); 0.71 (low hares)	0.75 - 1.00	0.85 (Purcells); 0.75 (Seeley Lake)	0 86	Few data	0 93 (in Core Release Area [CRA]); 0.82 (out of CRA)
Kitten Survival Rate	0.78 (high hares); 0 89 (low hares)	No estimate; recruitment thought low	0.58 (Seeley Lake)	0.12 (7 of 8 kittens died in 1st year)	No estimate; no evidence of kitten survival to independence	0.23
Lambda (Annual Rate of Population Change)	1.05 (1.16, high hares, 6 yrs; 0.88,low hares, 4 yrs)	No estimate	1.16 (Purcells, 4 yrs); 0.92 (Seeley Lake, 8 yrs)	No estimate	No es imate	0.93 - 1.08

[1]Estimators used to calculate home range size are provided in table 3.

4.2 Current Conditions - Detailed Descriptions by Geographic Unit

4.2.1 Unit 1 - Northern Maine

Unit Description: This geographic unit encompasses approximately 28,909 km^2 (11,162 mi^2) of northern hardwood and spruce-fir forest (the Acadian forest) in northern Maine that has been designated as critical habitat for lynx (79 FR 54823-54828). Land ownership in this unit is about 90 percent private, 7 percent State (primarily Baxter State Park), 1 percent Federal (the newly-designated Katahdin Woods and Waters National Monument and Appalachian Trail Corridor), and 1 percent Tribal (Passamaquoddy Tribe, Penobscot Indian Nation). Almost all private lands are intensively managed for commercial forest (timber and pulp) products. This unit is directly connected to lynx habitats and populations in southern Quebec and northern New Brunswick. Lynx in this unit represent the southern extent of a larger cross-border population, most of which

occurs in the Gaspe region of southern Quebec and northern New Brunswick (Ray *et al.* 2002, pp. 17-20) and which is geographically isolated by the St. Lawrence River from lynx populations in central Quebec (120 km [75 mi] north of Maine). Lynx populations in Maine and eastern Canada are also geographically isolated from other lynx populations on the island of Newfoundland (900 km [559 mi] northeast of Maine), and on Cape Breton Island, Nova Scotia (650 km [404 mi] east of Maine; Koen *et al.* 2015, entire; Prentice *et al*. 2017, entire). Lynx in Maine are also isolated from other DPS populations, the closest of which is in northeastern Minnesota, about 1,610 km (1,000 mi) west of this unit.

Lynx regularly occur outside this unit and recently have been documented in smaller areas of similar habitat in southeastern and southwestern Maine, northern New Hampshire, and the northeastern corner of Vermont (see below). Occasional lynx reproduction has been documented recently in New Hampshire and Vermont, but these areas are not thought to support persistent breeding populations and are likely incapable of doing so (see below). Climate in this region is characterized by warm summers and some of the coldest temperatures and highest snowfalls in the eastern United States; a function of latitude, elevation, and distance from the ocean. The average terrain rises in northern Maine to 305-457 m (1,000-1,500 ft) with mountain peaks, particularly in western Maine, northern New Hampshire, and Vermont, from 914-1,524 m (3,000-5,000 ft). Average annual precipitation is currently 104 cm (41 in), with greatest precipitation in winter in the form of snow (average total snowfall is 228-280 cm (90 - 110 in), with higher amounts at the highest elevations. Snow duration is about 5 months (mid-November through mid-April).

New Hampshire - Potential habitat in northern New Hampshire is limited (Hoving 2001, p. 59), and the few habitat patches that support lynx in New Hampshire are much smaller than those in northern Maine (Litvaitis and Tash 2005, fig. 2 and p. A–298; Robinson 2006, fig. 3.3, p. 99). Hoving estimated approximately 1,000 km^2 (386 mi^2) of potential habitat having a greater than 50 percent probability of being occupied by lynx (68 FR 40086). Litvaitis and Tash (2005, p. A–298) estimated that New Hampshire contains about 888 km^2 (343 mi^2) of potential Canada lynx habitat. Historical lynx occurrence in New Hampshire included Coos and northern Carroll and Grafton counties (i.e., White Mountain National Forest; Siegler and Jorgensen 1971: Silver 1974: Hoving *et al.* 2003). The majority of lynx records in northern New Hampshire over the past 10 years have occurred in the vicinity of Pittsburg on the 101-km^2 (39-mi^2) Connecticut Lakes Natural Area (CLNA), which is owned and managed by New Hampshire Fish and Game, and on surrounding habitat owned and managed by the Connecticut Lakes Timber Company under a conservation easement held by the State (Kilborn 2015, App. A, pp. 42-43). The CLNA, under a conservation easement, includes a 61-km^2 (23-mi^2) area that will be allowed to mature to a climax forest type which is contained within what is considered core lynx habitat. The area will potentially provide good denning habitat but will likely restrict the amount of snowshoe hare habitat in the foreseeable future. Current conditions are in a transition state, and portions of the core area currently support higher densities of snowshoe hare because of past forest management (Kilborn 2015, App. A pp. 42-43). Regional-scale modeling suggests that a high component of deciduous forest and insufficient snow conditions in New Hampshire make it

unlikely to support a persistent, viable lynx population over time (Hoving *et al.* 2005, pp. 739, 749).

Vermont – Recent modeling indicates that the Nulhegan River Basin contains Vermont's best lynx habitat (Farrell 2012). The 530-km^2 (205-mi^2) area is approximately 20 percent Federal (Nulhegan National Wildlife Refuge), 17 percent State (Vermont Department of Natural Resources), and 63 percent private commercial timber lands (with conservation easement). Vermont does not appear to have historically supported a persistent resident lynx population and, despite several recent verified records of lynx presence and evidence of limited reproduction (see section 2.3.2.2), it is unlikely to do so in the future because of the patchy and limited amount of potential habitat, climate change (decreasing snow), trends toward hardwood management, and increasing human disturbance (Vermont Fish and Wildlife 2015, Appendix A5 p. 127).

Habitat Description: Most lynx occurrence records in this unit are found within the broadly described ''Mixed Forest-Coniferous Forest-Tundra'' cover type (68 FR 40086). This habitat type occurs along the northern Appalachian Mountain range from southeastern Quebec, northern New Brunswick, and northern and western Maine, south through northern New Hampshire. This area is part of the Acadian Forest Region (Rowe 1972, p. 112-129) representing a transition between northern boreal spruce and balsam fir and southern temperate deciduous forests (Seymour and Hunter 1992, pp. 3-4). This forest type becomes naturally fragmented and begins to diminish to the south and west, with a disjunct segment running north-south through Vermont and a patch in the Adirondacks of northern New York (McKelvey *et al.* 2000a, pp. 248-250). Patches of boreal forest in New Hampshire, Vermont, and New York are more highly fragmented and smaller than in northern Maine. These more southerly forests also contain a higher proportion of northern hardwood and are believed to lack an adequate conifer component needed to produce sufficient snowshoe hare densities to consistently support resident lynx populations (Hoving *et al.* 2005, p. 749; Carroll 2007, p. 1100). Northern Maine is characterized by low-relief, hilly terrain, but with some higher elevations in the Katahdin Highlands and in western Maine. Higher elevations support a predominantly coniferous forest (white, red, and black spruce; balsam fir; eastern white pine [*Pinus strobus*]) intermixed with northern hardwoods (red maple, aspen, paper [white] birch, sugar maple [*Acer saccharum*], beech [*Fagus* spp.], and yellow birch [*Betula alleghaniensis*]). Lowland areas include spruce-fir flats interspersed with peatlands (black spruce, tamarack).

In this unit, lynx are most strongly associated with stands of regenerating sapling spruce-fir forest supporting high hare densities (Homyack 2003, p. 53; Fuller and Harrison 2005, p. 716, Vashon *et al.* 2008b, p. 1492; Scott 2009, pp. 24, 32, 36-44). Most current high-quality stands in this unit are the result of landscape-level clearcutting in the 1970s and 1980s (see Habitat Status, below). Regenerating stands used by lynx typically develop 15-30 years after timber harvest (Hoving *et al.* 2004, p. 291) or other disturbance (e.g., periodic spruce budworm defoliation), are characterized by high stem density and dense horizontal cover within 1 m (3 ft) of the ground (Robinson 2006 pp. 26-36, Scott 2009, pp. 81-93; Fuller and Harrison 2010, p.

1276-1278; Vashon *et al.* 2012, p. 15), and support the highest snowshoe hare densities (Homyack 2003, p. 63; Fuller and Harrison 2005, pp. 716, 719; Vashon *et al.* 2005a, pp. 10–11).

At the stand scale, lynx in northwestern Maine selected older (11- to 26-year-old), tall (4.6- to 7.3-m [15- to 24-ft]) softwood-dominated (spruce and fir) regenerating clearcut stands, adjacent older (11- to 21-year-old) partially harvested stands in close proximity to clearcut stands (Fuller *et al.* 2007, pp. 1980, 1983–1985), and mature conifer stands (Simons-Legaard *et al.* 2013, p. 568) where hares are more accessible. During winter, lynx primarily selected tall (4.4–7.3 m [15–24 ft]) regenerating clearcuts and established partially harvested stands that were 11–21 years post-harvest (Fuller *et al.* 2007, pp. 1984-1985). Lynx selected against mature second-growth stands (> 40 years old), short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partially harvested stands < 10 years post-harvest, and roads and road edges (Fuller *et al.* 2007, pp. 1980, 1983-1985). Research of year-round habitat use yielded similar results, with lynx preferentially using conifer-dominated sapling stands that were 3.4–7.3 m (11–24 ft) in height and supported high densities of snowshoe hares (Vashon *et al.* 2008b, pp. 1492-1495). At the home range scale, lynx select landscapes having extensive regenerating conifer forest, but also with some mature conifer forest (Simons-Legaard *et al.* 2013, pp. 572–573). Lynx tended to forage in areas with intermediate to high hare densities, where hares were more accessible to lynx compared to the densest (short regenerating) stands (Fuller and Harrison 2010, pp. 1276-1278). Lynx may select partially harvested and mature conifer stands in close proximity to clearcut stands because of increased ease of travel and access to hares along the extensive edges of the densest, high-quality (regenerating clear-cut) hare habitats (Simons-Legaard *et al.* 2013, p. 574). Lynx are more likely to occur in large landscapes having a high percentage (> 27 percent) of regenerating forest, and less likely to occur in landscapes with very recent clearcuts or extensive partial harvest (Hoving *et al.* 2004, pp. 291–292; Simons-Legaard *et al.* 2013, entire).

Denning habitat included various types of coarse woody debris including blowdown, deadfalls, and root wads. In northern Maine, nearly half (12 of 26) of natal dens occurred in conifer-dominated sapling stands, and 6 dens were found in mature or mixed multi-story forest stands dominated by conifers (Organ *et al.* 2008, pp. 1515-1517).

In general, landscape scale and home range scale habitat selection by lynx on commercial forest lands reinforces the importance of dense regenerating conifer forest along with a component of mature conifers (Hoving *et al.* 2004, p. 286; Vashon *et al.* 2008b, pp. 1494-1495; Simons 2009, pp. 64-110; Simons-Legaard *et al.* 2013, p. 568). Simons-Legaard *et al.* (2013, p. 573) found the probability of lynx occurrence was > 50 percent where landscape hare densities were > 0.74 hares/ha (0.39 hares/ac) and there was > 10 percent mature conifer forest. No lynx maintained home ranges in landscapes with hare densities < 0.5 hares/ha (0.2 hares/ac). At a landscape scale, lynx habitat selection did not differ between sexes; however, at a home range scale, males tended to use more mature forest dominated by conifers than females, and both male and female lynx tended to avoid mature forests that had a high deciduous component (Vashon *et al.* 2008b, pp. 1492-1493). Based on these observations, Simons-Legaard *et al.* (2013, pp. 574-576) recommended maintaining landscape hare densities of > 0.5 hares/ha (0.2

hares/ac) and a minimum of 27 percent high-quality hare habitat within 100-km^2 areas to conserve lynx.

Habitat Status: As elsewhere in the DPS, boreal spruce-fir forest habitats in the Northern Maine Unit are naturally patchily-distributed and intermixed with northern hardwoods, riparian areas, and peatlands. USFS forest inventory data indicate that over 16,000 km^2 (6,178 mi^2) of forestland are classified as spruce-fir in Aroostook, Penobscot, Piscataquis, and Somerset Counties in northern Maine (McWilliams *et al.* 2005, p. 122), although not all of this forest type is in areas occupied by lynx. Currently, most of the high-quality hare and lynx habitat in northern Maine is the result of extensive landscape-scale clearcut timber harvesting in response to a spruce budworm outbreak in the 1970s–1980s (Hoving *et al.* 2004, p. 291; Simons 2009, pp. 64, 218). Many of these clearcuts were also treated with herbicides to promote conifer regeneration by suppressing deciduous tree species. After salvage harvest of the affected trees, a portion of the area was sprayed with herbicide to reduce deciduous competition (Scott 2009, pp. 7, 14). The resulting vegetation was dominated by balsam fir and red or black spruce (Scott 2009, p. 60). This created favorable habitat conditions for snowshoe hares and lynx. Habitat conditions for hares and lynx in the unit improved from the late-1980s to present, benefitting from stand-replacing salvage harvests during the last budworm outbreak (Simons 2009, pp. 122-229; Simons-Legaard *et al.* 2016, entire). During this time period, the percentage of forestland with an average landscape hare density greater than 0.5 hares/ha (0.2 hares/ac) increased 400 percent (Simons-Legaard *et al.* 2016, p. 7). Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was typically in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56).

In the Northeast prior to European settlement, lynx habitat was created and maintained by frequent, small-scale forest gap dynamic events and infrequent, large-scale stand-replacing forest disturbances (Seymour *et al.* 2002, pp. 359-365; Lorimer and White 2003, pp. 54-58). Historically, the natural disturbance regime (fires, windthrow, insect outbreaks) resulted in smaller, more frequent disturbances and long intervals between larger disturbances; thus, high-quality lynx foraging habitat in northern Maine was probably typically much less abundant and less broadly-distributed than it is today. Large, stand-replacing events (fire, wind and ice storms, insect outbreaks) are rare (intervals of several hundred to several thousand years) and highly variable in size (Seymour *et al.* 2002, entire; Lorimer and White 2003, pp. 50, 54, 59). Spruce budworm, spruce beetle, beech bark disease, and sugar maple defoliators have been important influences affecting forest landscape patterns (McNab and Avers 1994, Chapter 14). The frequency and intensity of spruce budworm outbreaks, the most likely insect to affect lynx habitat, have been highly variable in Maine and eastern Canada in recent centuries (Blais 1983, entire). Although, high-elevation boreal forests often exhibit dense, regenerating conifer (resulting from a wind-throw phenomenon known as fir-waves [Sprugel 1976, entire]), hare densities are believed to be low in these areas (Siren *et al.* 2015, entire). In this geographic area, wildfire is less significant as a natural agent of disturbance. The typical fire regime is infrequent surface fires in the dormant season in the hardwood forests, and slightly more frequent but long-interval fires in conifer forests (Kilgore and Heinselman 1990, entire; Seymour

et al. 2002, pp. 359-365, Lorimer and White 2003, p. 59). For the past several decades, early successional forests and lynx habitat in northern Maine, New Brunswick, and southern Quebec have been created almost exclusively by forest management (Lorimer and White 2003, pp. 42-43).

In a roughly 14,500-km^2 (5,598-mi^2) area in northern Maine (about half of the Northern Maine geographic unit), Simons-Legaard (2016, p. 9-10) estimated that 3,845 km^2 (1,485 mi^2; nearly 27 percent) of the forested landscape was comprised of spruce-fir in a young, regenerating stand condition that provide high-quality hare habitat. This habitat is similar to, and contiguous with, forested areas in Quebec and New Brunswick that support lynx (Hoving *et al.* 2005, pp. 740-741). The current range of lynx in this unit is associated with areas of deep snowfall, extensive forested landscapes, and areas having a high proportion of regenerating conifer-dominated forest that had previously been clearcut and treated with herbicides to suppress hardwoods (Homyack 2003, p. 2; Hoving *et al.* 2004, p. 287).

Snowshoe hare populations in Maine do not seem to cycle at 10-year intervals, but they have experienced a period of higher (1995-2005) and lower (2006 to present) densities (Scott 2009, pp. 1-44; Vashon *et al.* 2012, p. 14; Harrison *et al.* 2016, entire). Prior to 2006, several estimates of hare densities in the highest-quality regenerating conifer or mixed forest averaged 1.9 to 2.1 hares/ha (0.8 to 0.9 hares/ac; Homyack *et al.* 2007, p. 8; Robinson 2006, p. 26). After 2006, hare densities declined by about half in all stand types and have remained at these lower levels (Scott 2009, p. 109; D. Harrison, Univ. Maine, *unpubl. data*). Similar trends were observed in the Gaspe Region of Quebec (Assells *et al.* 2007, entire). In New Hampshire in 1990, hare densities in dense, regenerating spruce-fir stands were about 0.5 hares/ha (0.2 hares/ac) at low and high elevations (Brocke *et al.* 1993, p. 61). More recently, Siren *et al.* (2015) reported lower densities in New Hampshire (0.25 to 0.36 hares/ha [0.1 to 0.15 hares/ac]) that are unlikely to support lynx persistence in both montane and lowland spruce-fir. Densities in high elevation areas (krumholtz, stunted spruce-fir) were only 0.19 to 0.28 hares/ha (0.08 to 0.11 hares/ac), also unlikely to support lynx persistence. Comparable hare density data are not available for Vermont.

Currently, the amount and distribution of high-quality habitat are likely at historically high levels, but this habitat has peaked and high-quality lynx habitat is projected to decline in the near future (Simons-Legaard *et al.* 2016, pp. 140-163, 202-218). In response to the widespread clearcutting in the 1970s and 1980s, Maine passed the Forest Practices Act in 1989, which regulated clearcutting. Since then, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine. Partially harvested stands (e.g., selection harvest, shelterwood harvest, overstory removal) have a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006, p. 29). On average, partially harvested stands support about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006, p. 26-27). Over 95 percent of cutting that occurs now in northern Maine is partial harvesting compared to 59 percent in 1988 (Scott 2009, p. 8; Simons 2009, pp.45-47, 69-71; Simons-Legaard *et al.* 2013). This new cutting regime results in lower landscape densities of snowshoe

hares (Fuller 1999; Homyack 2003; Robinson 2006; Scott 2009). Another consequence of partial harvesting is that a much greater acreage needs to be cut annually to attain similar harvest volume (as compared to clearcutting). Annual harvest rates have increased from about 40,000 ha (100,000 acres) per year (before the Forest Practices Act) to over 200,000 ha (500,000 acres) per year (after the Act). Thus, 28 years after the Maine Forest Practices Act, much of the forested landscape in northern Maine has been partially harvested.

Unlike Federal lands, there is no requirement that private landowners comply with lynx management guidelines, and a Federal nexus for review of forestry projects rarely exists. Furthermore, there continues to be high turnover in forest land ownership (Hagan *et al.* 2005; Ippoliti and Nadeau-Drillen 2006) and little funding to provide incentives or to work with private landowners. As of 2005, there were 23 landowners in northern Maine with land holdings in excess of 40,000 ha (100,000 ac) including the State, Federal government (White Mountain National Forest south of lynx range), a conservation group (The Nature Conservancy), 2 tribes (Penobscot Indian Nation and Passamaquoddy Tribe with much land south of lynx range) and 18 private forest landowners (Ippoliti and Nadeau-Drillen 2006, p. 13).

Although long-term, binding land management commitments are generally lacking in the northern Maine unit, several landowners have made short-term commitments to conserving lynx habitat. In 2003, Congress passed the Healthy Forest Restoration Act. Title V of this Act designates a Healthy Forest Reserve Program (HFRP) with objectives to: (1) promote the recovery of threatened and endangered species, (2) improve biodiversity, and (3) enhance carbon sequestration. In 2006, Congress provided the first funding for the HFRP, and Maine, was 1 of several pilot States to receive funding through its Natural Resources Conservation Service (NRCS) State office. Based on a successful pilot program, in 2008, the HFRP was reauthorized as part of the Farm Bill, and in 2010, NRCS published a final rule in the Federal Register (75 FR 6539) amending regulations for the HFRP based on provisions amended by the bill. In 2006 and 2007, the NRCS offered the HFRP to landowners in the proposed Canada lynx critical habitat unit in Maine to promote development of Canada lynx forest management plans. Since that time 4 private landowners, The Nature Conservancy, the Passamaquoddy Tribe, Merriweather LLC, and Katahdin Forestlands successfully enrolled in the program. Collectively, these land ownerships comprised 2,443 km^2 (943 mi^2), or 9.3 percent of the total designated critical habitat in northern Maine in 2014 (79 FR 54828).

The NRCS required that lynx forest management plans must be based on the Service's ''Canada Lynx Habitat Management Guidelines for Maine'' (McCollough 2007, entire). These guidelines were developed from the best available science on lynx management for Maine. The guidelines required maintenance of landscapes having hare densities that support reproducing lynx populations. Notably, HFRP forest management plans provided a net conservation benefit for lynx, which was achieved by employing the lynx guidelines, identifying baseline habitat conditions, and meeting NRCS standards for forest plans. Plans met NRCS HFRP criteria and guidelines and complied with numerous environmental standards. Plans were reviewed and approved by the NRCS with assistance from the Service.

Unlike lynx forest plans on Federal lands, HFRP plans lack long term commitments beyond an initial 10-year contract period, after which longer-term commitments to lynx management are voluntary. Plans were prepared for a forest rotation (70 years) and include a decade-by-decade assessment of the location and anticipated condition of lynx habitat on the ownership. Some landowners developed plans exclusively for lynx, and others combined lynx management (umbrella species for young forest) with American marten (umbrella species for mature forest) and other biodiversity objectives. All 4 plans have been completed although contracts with NRCS expired as of 2017. Landowners have the option to convert HFRP contracts into Safe Harbor Agreements or other agreements to provide regulatory assurances, however, at this time this option has not been explored with landowners.

Many large private forest landowners in the northern Maine unit could potentially include lynx management as part of endangered species management required by forest certification programs. For example, The Nature Conservancy land enrolled in the HFRP is also enrolled in the Forest Stewardship Council (FSC) forest certification program. Other landowners are certified under the Sustainable Forestry Initiative (SFI). Both certification programs require protection of threatened and endangered species (FSC 2010, pp. 24, 27; SFI 2015, pp. 6-7). However, certification programs are also voluntary and may not include long-term commitments. Few certified landowners have consulted with the Service on forest management for lynx. In addition, "working woodland" easements now encompass > 10,000 km^2 (3,861 mi^2) across northern Maine; although these covenants do not require specific management practices or outcomes beyond sustainable forestry, they do ensure that conversions to other land uses will never occur (MDIFW 2017, p. 2).

Lynx Status: Historically, Maine seems to have consistently had a breeding population of lynx. Early written accounts did not consistently distinguish bobcats from lynx (Hoving 2001). Prior to 1939, lynx observations were based largely on written accounts of lynx from museum records, journals, and periodicals (Vashon *et al*. 2012, p. 56). Hoving *et al*. (2003, pp. 368-369) compiled 118 lynx occurrence records (509 individual lynx) from 1833-1999, which suggest that lynx were widespread throughout the state except for the coastal areas. These records included 39 kittens representing at least 21 litters, primarily in northern and western Maine, from 1864-1999 (Hoving *et al*. 2003, p. 371). Populations apparently fluctuated, and in some years 200-300 lynx were harvested in Maine (Hoving *et al*. 2003, pp. 373-374). Lynx were later documented in winter snow track surveys conducted by MDIFW during 1994-1998 (Vashon *et al*. 2012, p. 56).

When the DPS was listed, lynx were known to be present in northern Maine but little was known about their distribution, population size and trend, snowshoe hare populations, and relationships to forest management. Since then, research from the MDIFW (Vashon *et al.* 2008a, entire; 2008b, entire; and 2012, entire) and the University of Maine (Hoving *et al.* 2003, entire; Hoving *et al.* 2004, entire; Hoving *et al.* 2005, entire; Homyack *et al.* 2005, entire; Homyack *et al.* 2007, entire; Homyack *et al.* 2006, entire; Fuller *et al.* 2007, entire; Fuller *et al.* 2004, entire; Fuller and Harrison 2005, entire; Simons-Legaard *et al.* 2013, entire; Simons-Legaard *et al.* 2016, entire) have greatly increased our knowledge. Snow track surveys and confirmed occurrence records document that lynx occur throughout northern Maine and in small, isolated pockets in western

and eastern Maine (Vashon *et al.* 2012, pp. 10, 12, 59), and small numbers of lynx have also been documented recently in northern New Hampshire (Siren 2014b, pp. 7-16), and Vermont (Bernier 2015, entire). Population size and trend are still uncertain in northern Maine, and persistence in New Hampshire and Vermont remain questionable.

This geographic unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspe region of southern Quebec. Extensive areas of contiguous forestland in this region provide high connectivity between populations in Maine and Canada. Lynx populations in adjacent southern Quebec may exhibit cyclic populations (Ray *et al*. 2002, entire), but obvious immigration of large numbers of lynx into Maine associated with hare cycles (if they occur) has not been documented (Hoving *et al*. 2003, pp. 373-374). Although potential lynx habitat in New Hampshire and Vermont is fragmented, there is near contiguous forest and connectivity for lynx movement between these areas and habitats in northern Maine (Farrell 2013, *pers*. *comm*.; 79 FR 54821). Areas of recent lynx breeding in New Hampshire and Vermont are not directly connected to Canadian populations, but they are connected to the larger population in northern Maine via habitat corridors in western Maine.

Lynx in the Northern Maine Unit and adjacent populations in southern Quebec and northern New Brunswick are separated from lynx populations in the interior of Canada. The St. Lawrence River restricts lynx dispersal and demographically isolates this population from those in northern Quebec, Labrador, and Ontario (Prentice *et al*. 2017, entire). However, sufficient numbers of individuals apparently cross the river on the ice each generation to prevent genetic drift of this population (Koen *et al.* 2015, enitre; Prentice *et al*. 2017, entire).

When the DPS was listed, the Northern Maine Unit was not believed to contribute significantly to its persistence. However, we now believe that the extensive young, regenerating spruce-fir habitat created by large-scale clearcutting in the 1970s and 1980s may currently support the largest lynx population in the DPS (Vashon *et al.* 2012, pp. 58-59, Appendix IV; Vashon *in* Lynx SSA Team 2016a, p. 18). Habitat in northern Maine supported lynx densities in a localized area of high-quality habitat that was substantially greater than densities elsewhere in the DPS (ILBT 2013, p. 23). In 2003 when hare populations were high, lynx density (juveniles and adults) in one of Maine's highest-quality habitats was estimated to be 9.2-13.0 lynx/100 km^2 (Vashon *et al.* 2008a, Vashon *et al.* 2012, p. 15). At about the same time, the density of lynx in nearby Gaspe Peninsula, Quebec was estimated to be 10 lynx/100 km^2 (Ray *et al.* 2002). These densities are intermediate to those in Canada during the high (17-45/100 km^2) and low periods (2.3-3.0/100 km^2) of the lynx-hare cycle (Poole 1994, Slough and Mowat 1996, O'Donaghue *et al.* 1997). Simons (2009, p. 102) estimated that habitat on a 14,407-km^2 (5,563-mi^2) study area (about half of the geographic unit) in northern Maine could potentially support a population of 236 to 355 adult lynx, and Vashon *et al.* (2012, pp. 58-59 and Appendix IV) estimated the potential for a population of 750 to 1,000 adult lynx in all of northern Maine in 2006. The actual number of lynx, however, is unknown because there are no methods available to count individuals over such a large geographic area.

Lynx seem to have maintained a similar distribution throughout northern Maine since the 1970s, and are found primarily north of Moosehead Lake and west of Interstate 95, with scattered pockets in western and eastern Maine (Hoving *et al*. 2003, p. 369; Vashon *et al*. 2012, pp. 10-12.) Resident lynx in small pockets of habitat outside of the core range in Maine (including New Hampshire and Vermont) may occur only ephemerally, winking on an off over time as would be expected at the periphery of the range of a metapopulation structure, and as suspected for other lynx populations at the periphery of the range (McKelvey *et al.* 2000b, pp. 25-31; Apps 2007, pp. 81, 95-104). From 1995-1998 and 2003-2008, the MDIFW conducted snow track surveys in 66 townships to document the distribution of lynx and to inform habitat modeling at the University of Maine (Vashon *et al*. 2012, p. 91). Modeled areas of potential lynx habitat were well-distributed throughout northern Maine in the early 2000s (Simons-Legaard *et al*. 2016, entire).

Lynx populations in New Hampshire and Vermont may consist of only a few animals and they may be ephemeral, although breeding has been documented in both locations in recent years. Most historical lynx records from New Hampshire are from trapping records from the 1930s to the 1960s (Brocke *et al.* 1993, pp. 71-74; McKelvey *et al.* 2000a, pp. 212-214). There were only 2 records in the 1990s. In 2003, the Service determined that, despite a lack of breeding records, a small resident population likely occurred historically in New Hampshire but no longer exists (68 FR 40087). Lynx were detected in northern New Hampshire in 2006 and have occurred there annually since then (Siren 2014b, pp. 53, 55). In 2011, 4 lynx kittens were observed in Pittsburg and were considered evidence of breeding in New Hampshire (Kilborn 2015, Appendix A, p.44). There were only 4 historical records of lynx in Vermont prior to 2003. Since then, 9 lynx sightings have been confirmed, and reproduction was confirmed in 2012 in the Nulhegan Basin when the tracks of 3 lynx, a presumed family group, were observed travelling together in late February (Vermont Fish and Wildlife 2015, Appendix A5, p. 126). Since 2012, more intensive surveys in Vermont have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). Landscape hare densities are marginal in these areas; 0.52 hares/ha (range 0.12-0.58 hares/ha) in the Nulhegan Basin of Vermont and 0.12-0.23 hares/ha in the White Mountain National Forest (Siren 2017, pp. 13, 23, 24), which may explain why lynx rarely occur.

Maine lynx had spatial and demographic parameters similar to some northern populations during the cyclic high in the snowshoe hare cycle (Brand *et al.* 1976, Parker *et al.* 1983, O'Donaghue *et al.* 1997). From 1999 to 2011, biologists with the MDIFW trapped and radio-marked 85 lynx in northern Maine and documented lynx movements and home range (Vashon *et al*. 2008a, entire; Mallet 2014, pp. 69-93), resource use (Vashon *et al*. 2008b, entire), survival (Vashon *et al*. 2012, pp. 18-21), productivity (Vashon *et al*. 2012, pp. 17-19), and other aspects of their life history (Vashon *et al*. 2012, entire). During the period when snowshoe hare populations were highest (2000-2006), Maine lynx had among the highest reproductive rates in the DPS (89 percent of adult females produced litters, average litter size was 2.74, and kitten survival was 78 percent) (Vashon *et al.* 2012, pp. 18-21). During the current (2006-present) period of lower hare density, only 30 percent of females had litters and average litter size was smaller (2.25), but kitten survival rate remained high, and was actually somewhat higher during the lower hare years (89 percent from 2006-2010, compared to 78 percent from 1999-2005;

Vashon *et al*. 2012, p. 21, table 1.5). Maine lynx have among the smallest home ranges documented in the DPS (Vashon *et al*. 2008a, p. 1482; ILBT 2013, p. 24; also see tables 3 and 4). Home range sizes were similar during periods of higher and lower hare density (Mallett 2014). Lynx populations likely increased during the period of high hare density (lambda [λ] = 1.16) and declined during periods of low hare density (λ = 0.88; USFWS, Vortex 10, deterministic population simulation 2016; demographic data from Vashon *et al.* 2012, pp. 17-21).

In summary, Maine lynx and hare habitats are believed currently to be at historical highs as a result of forest regeneration following widespread clearcutting in the 1970s and 1980s and subsequent use of herbicides to suppress hardwoods in response to a spruce budworm outbreak (Hoving *et al.* 2004; Vashon *et al.* 2008b). In the Northeast prior to European settlement, lynx habitat was created and maintained by small-scale, frequent forest gap dynamic events and large-scale, infrequent (stand-replacing) forest disturbances (Seymour *et al.* 2002; Lorimer and White 2003). Historically, lynx distribution was patchy, and lynx populations likely fluctuated and may have been more dependent on immigration from Canada. At multiple scales, lynx in Maine select extensive areas of regenerating, dense (7,000 – 14,000 stems/ha) spruce-fir stands 15 to 35 years after clearcut, other even-aged harvest, or natural disturbance (Hoving *et al.* 2005; Fuller *et al.* 2007; Vashon *et al.* 2008b; Simons-Legaard *et al.* 2013). The unnaturally high amount of high-quality lynx habitat in this unit is expected to decline by 2030 because of changing forest practices, before stabilizing or increasing again by 2060 (Simons-Legaard 2016, p. 10, fig. 8; Simons-Legaard *et al.* 2016; see 5.2.1, below).

Factors Affecting Current Conditions

Regulatory Mechanisms - In response to public concern about widespread clearcutting in northern Maine (described above), in 1989 the Maine Legislature passed the Maine Forest Practices Act (MFPA). The MFPA regulates maximum size of clearcuts (about 100 ha [250 ac]), separation zones between clearcuts, harvest plans, and notification to the Maine Forest Service. Clearcuts are not banned, but require varying levels of State permits depending on their size. As a result of these regulatory requirements, clearcuts have declined substantially in annual number and acreage and have been replaced by various forms of partial harvesting (Sader *et al.* 2003, p. 349-350; McWilliams *et al.* 2005, p. 35; Legaard *et al*. 2015, pp. 14-21). Following passage of the MFPA, the percentage of acreage clearcut annually in Maine declined from 44 percent of annual harvest in 1989 to < 5 percent in 2004 (Simons 2009, pp. 45-46; Legaard *et al*. 2015, p. 18). The average size of clearcuts has been reduced from > 50 ha (125 ac; Maine Forest Service 1995, entire) to < 10 ha (25 ac; Maine Forest Service 2003, entire; 2005, entire; 2007, entire). Currently, partial harvesting comprises about 94 percent of acres cut annually in Maine (Simons 2009, p. 50). Although total timber volume harvested has changed relatively little, landowners must partial harvest about twice as many acres to harvest the same volume of wood annually that they would with clearcutting (Legaard *et al*. 2016, p. 18). Thus, the annual forest area harvested in Maine has increased from about 100,000 ha (250,000 ac) pre-MFPA to 223,000 ha (550,000 ac) post-MFPA (McWilliams *et al.* 2003, p. 35).

Currently, 28 years after implementing the MFPA, much of the 4 million-ha (10 million-ac) northern Maine landscape has been partially harvested (Legaard *et al*. 2016, p. 16) – some areas on multiple occasions. The partial harvests that replaced clearcuts include a variety of silvicultural treatments, including both even-aged (e.g., shelterwood) and uneven-aged (e.g., selection) management that result in a wide range of residual stand conditions (Robinson 2006, pp. 5-37), which have important implications for lynx conservation. Snowshoe hare densities in partially harvested forests are on average about 50 percent lower (but range from 20 to 90 percent lower) than in regenerating conifer stands created by clearcutting (Robinson 2006, pp. 5-37; Scott 2009, p. 109; Simons 2009, p. 83), thus reducing landscape hare density and, thererofe, lynx habitat quality in this unit (Simons 2009, pp. 206, 209, 217; Simons-Legaard *et al.* 2016, p. 7-8; Simons-Legaard 2016, entire). Landscape level hare densities have declined with extensive partial harvesting and aging of the spruce budworm-era clearcuts, and future declines are anticipated (Simons-Legaard *et al.* 2016, 9-10; also see section 5.2.1).

Climate Change - Climate change is affecting temperature, snow, and precipitation patterns in the Northeast at rates faster than expected (Rustad *et al.* 2012, p. 6). Rapid winter warming in recent decades is believed to be influenced by an albedo effect caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42° - 0.46°C/decade (0.76° - 0.83 °F/decade) with the greatest warming occurring in the winter months, especially January and February (Burakowski *et al.* 2008). Under mid- to high-emissions scenarios, average mean temperatures in northern Maine are projected to increase by 6.7° - 7.8°C (12° - 14°F) by 2080-2099 relative to 1971-2000 (Galbraith *et al*. 2013, p. 43). Under a higher emissions scenario, snow covered days in northern Maine (from December to February) could decrease from 30 days per month observed from 1961-1990 to about 18-20 days per month in 2070-2099 (Galbraith *et al*. 2013, p. 49). Climate warming may have already affected lynx habitat in this unit by reducing the distribution of favorable snow conditions and boreal forest vegetation, and it is likely to continue to do so in the future (see section 5.2.1).

Snow Duration, Depth, and Quality - As noted in chapter 2, records of lynx occurrence are correlated with areas that regularly have at least 4 months (120 days) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Snow cover days in northern New England (1965-2005) ranged from 60-121 days and declined an average of 3.6 days/decade from 1965-2005 (Burakowski *et al.* 2008). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another 2 weeks in Maine by mid-century (Fernandez *et al.* 2015). Thus, average conditions in Maine are currently at or below the snow cover duration correlated with historical lynx occurrence records. Similarly, the largest decreases in snow depth observed in Canada in the last 6 decades have occurred in the lower St. Lawrence Valley, immediately north of Maine (Brown and Braaten 1998, pp. 48-52).

Lynx in the northeastern United States and eastern Canada occur where average annual snowfall typically exceeds 270 cm/yr (106 in/yr; Hoving *et al.* 2005), which defines the distribution of lynx (to the north) and bobcat (to the south) in this region (Hoving *et al.* 2005; Carroll 2007; Peers *et al.* 2013). Average annual snow depth at all 5 NOAA weather stations within the range of the lynx in northern Maine (1981-2010) was below this threshold and ranged

from 228-263 cm (90-104 in; NOAA 2011[14]). In the last 50 years, 18 of 23 snow sampling sites in and near Maine experienced reduced depth of snowpack (Hodgkins and Dudley 2006). Snow depth in New England (1965-2005) declined an average of 4.6 cm/decade (1.8 in/decade; Burakowski *et al.* 2008). Thus, average annual snowfall in Maine is currently at or below depths associated historically with lynx presence, and further declines could reduce the likelihood that resident lynx will persist in this unit (Hoving *et al.* 2005).

As noted in chapter 2, deep, unconsolidated and persistent snow is thought to provide lynx with a competitive advantage over other terrestrial hare predators and gives snowshoe hares the ability to reach winter browse. Snow quality ("fluffiness") has deteriorated and snow density has increased in the Northeast. Unlike other units, annual precipitation in Maine is increasing because of climate change, but primarily as rain (Siren *in* Lynx SSA Team 2016a, p. 15; Fernandez *et al.* 2015), and especially rain on snow events in winter in northern Maine (Huntington *et al*. 2004; Deser *et al.* 2014; Fernandez *et al.* 2015). Snow density and compaction and crust conditions (caused by wet, heavy snow or rain on snow events in winter) have increased in northern New England (Dudley and Hodgkins 2002; Huntington *et al.* 2004; Huntington 2005; Hodgkins and Dudley 2006) and southern Canada (Karl *et al.* 1993).

Vegetation Management - The effects of forest management on foraging and denning habitat for lynx in northern Maine are discussed in the Habitat Description, Habitat Status, and Regulatory Mechanisms sections above. As described there, past vegetation management in the form of landscape-level clearcutting (sometimes followed by herbicide application to promote softwood regeneration) of budworm impacted forests is responsible for the current historically high amount of high-quality hare (and therefore lynx forgaing) habitat in this unit. The amount of high-quality habitat created by these densely-regenerating stands probably peaked in the late 1990s – early 2000s and is expected to decline over the next several decades (see section 5.2.1).

Wildland Fire Management - Although fire is frequent in many boreal forest regions, it is not a stressor for lynx in northern Maine and likely played a minimal role historically in creating and maintaining lynx and hare habitats. Annual precipitation is comparatively greater in this unit than others, and conditions for large fires occur infrequently. The fire regime in this unit is one of infrequent (50- to 200-year interval) and generally small (several acres) surface fires in the dormant season. Large (up to 32,375 ha [about 80,000 ac]) stand-replacing fires are rare and occur at a less frequent interval (800 to 9,000 years; Seymour *et al.* 2002, p. 360). In contrast, spruce budworm outbreaks cause stand-replacement over large areas every 100–250 years (Cogbill, 1985).

Habitat Fragmentation - Habitat fragmentation (smaller and more isolated patches of high-quality hare habitat) caused by current forest practices in northern Maine is discussed in the Habitat Description and Habitat Status sections above.

[14] http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html, https://www.currentresults.com/Weather/Maine/annual-snowfall.php, last accessed 3.31.2016.

Other Factors: *Trapping* - This unit is directly connected to lynx habitats and populations in southern Quebec, where trapping of lynx is legal. In areas where lynx are trapped for furs (Canada and Alaska), trapping can be additive to other sources of mortality and have population-level effects (Brand and Keith 1979; Koehler and Aubry 1994). Thus, harvest regulations for lynx are modified (e.g., lynx quotas per trapper are reduced) when hare and lynx populations are low (Bailey *et al.* 1986). About 400 lynx are trapped and killed annually in Quebec south of the St. Lawrence River[15]. Several lynx that were captured and radio-marked in northern Maine were subsequently trapped in southern Quebec (Vashon *et al.* 2012).

Lynx trapping and hunting seasons were closed in Maine in 1967 (Vashon *et al*. 2012, p. 28) and also in New Hampshire and Vermont for decades prior to the DPS being listed under the ESA. In 2014, the MDIFW worked with the Service to develop an *Incidental Take Plan for Maine's Trapping Program* (MDIFW 2014, entire; 2015a as amended, entire) and obtained a permit from the Service for lynx trapped incidental to other furbearer trapping in Maine (see section 3.1.2). Trapping injury and mortality are not believed to have a population-level effect on lynx in northern Maine and adjacent Canada when lynx may be at historically high numbers, but increased, targeted lynx trapping in southern Quebec could have a synergistic and negative effect if hare and lynx populations decline, habitat declines, or climate change further stresses lynx (Slough and Mowatt 1996; Carroll 2007, pp. 1099-1103). Carroll (2007, pp. 1099-1103) modeled lynx populations in this unit and demonstrated that increased trapping pressure in Quebec could, combined with projected clmate warming and associated snow loss, have a negative effect on protected lynx populations in Maine and New Brunswick.

Wind Power Development - Interest in wind energy development has increased in northern and western Maine, and such development could impact high- and low-elevation spruce-fir habitats (Whitman *et al.* 2013). Maine has experienced a rapid increase in wind energy development[16], and there is increased interest in placing developments on private lands in unpopulated areas in northern Maine, New Hampshire, and Vermont. Wind energy is an increasingly appealing source of income for investment companies and other landowners who own forestland in the northern Maine unit. As of 2016, at least 11 wind projects have been proposed in northern and western Maine and 5 projects are in operation; 2 have been proposed in northern New Hampshire and 2 are in operation; and 3 have been proposed for northeast Vermont and 2 are in operation or under construction. Maine's 2 largest wind projects (combined over 250 turbines covering 932 km^2 [360 mi^2]) are proposed entirely within Maine's designated lynx critical habitat. Although impacts of wind energy projects on lynx, hares, and their habitats have not been demonstrated, potential effects include loss and fragmentation of habitat from turbines, roads, and transmission lines, and disturbance or displacement of resident lynx. Road construction could further fragment habitat and increase access, potentially increasing vehicle collisions with lynx and other sources of mortality, including incidental trapping or illegal shooting (also see 5.2.1).

[15] http://mffp.gouv.qc.ca/english/wildlife/statistics/index.jsp, last accessed 5.19.2016.
[16] http://www.eia.gov/electricity/data/browser, last accessed 8.2.2016.

Changing Land Ownership and Development - Until recently, the northern Maine unit was largely undeveloped and owned primarily by about a dozen large, commercial timber interests, but land ownership patterns have changed dramatically in the last 15 years (Ippoliti and Nadeau-Drillen 2006). Large tracts of land have been sold, lumber and pulp mills shut down, and much of the area has been sold to investment-oriented owners. Some of these new landowners are seeking diversified financial returns on their investment, including developing residential housing, second homes, and resorts. At various times in the past, 2 large residential and resort areas have been proposed on forestlands within designated lynx critical habitat in this unit. Both projects, if eventually built as previously-planned, could result in the development of several thousand acres of potential lynx habitat, but would be mitigated by substantial (100,000s of acres) conservation easements on surrounding forestland. Also, a private landowner recently purchased and donated 354 km^2 (137 mi^2) within designated lynx critical habitat that was subsequently designated as the Katahdin Woods and Waters National Monument. This area currently has a legacy of young regenerating spruce-fir habitat from previous commercial timber harvest, but its new monument designation will limit future forest management activities (timber harvest or other vegetation management) that could benefit lynx. In addition, the Nature Conservancy continues forest management on about half of its 750-km^2 (290-mi^2) ownership in this unit, including managing part of the area for lynx.

Construction or expansion of developed areas such as residential areas and resorts and smaller recreational sites like Nordic ski huts or campgrounds may directly remove forest cover. Such habitat alteration and associated human recreation in lynx habitat could result in a more fragmented landscape and localized decreases in prey availability, and could affect lynx movements within home ranges or displace lynx from high-quality habitats. As with energy development, road and highway construction often associated with residential and recreational development can further fragment habitat and, with associated increases in traffic volumes and/or speeds and human access, can increases the likelihood of lynx mortality and injury from vehicle collisons and incidental or illegal trapping or hunting.

In summary, lynx were historically and are currently widespread throughout northern Maine, and they currently occur (and probably occurred historically) as small resident or ephemeral populations in small patches of habitat outside this geographic unit in eastern and western Maine, northern New Hampshire, and northern Vermont. According to MDIFW, habitat in northern Maine may currently support a potential population of 750 to 1,000 lynx. High-quality habitat created by extensive clearcutting 30 to 40 years ago is peaking and is projected to decline by 50 percent in the next 15 to 20 years (Simons-Legaard 2016, pp. 10-18; also see section 5.2.1). Hare densities declined by 50 percent in this unit starting in about 2006 and have remained at lower levels, and future hare fluctuations or cycles are uncertain. Recent history demonstrates that some forms of forest management have the potential to create or increase lynx habitat. However, forest practices have shifted to partial harvesting, which is less likely to create large areas of lynx habitat or maintain the current historically broad distribution of high-quality habitat generated by previous landscape-level clear-cutting. Additionally, private landowners who previously entered into commitments to manage for lynx conservation have not renewed those commitments (although the habitat will remain viable for lynx for some time).

Land ownership has also changed in northern Maine, and the majority of lands are owned now by investment companies that often wish to diversify income from their investments, which could result in forest practices inconsistent with lynx habitat conservation. Without long-term, binding land management commitments in this unit, there is no guarantee that the current historically high amount of lynx habitat will be maintained by future forest managment practices on private lands. The greatest stressors to resident lynx in this unit are habitat loss (as a result of the shift in forest management from clearcutting to partial harvesting resulting in lower landscape hare densities), lack of forest planning for lynx, and projected continued climate warming (diminishing snow depth, quality and duration; transition from spruce-fir to northern hardwood forests; potential increased competition from bobcats and fishers; and increased future isolation of lynx in this unit and southeastern Canada because of diminishing ice conditions on the St. Lawrence River/Seaway).

4.2.2 Unit 2 - Northeastern Minnesota

Unit Description: This geographic unit encompasses approximately 21,100 km^2 (8,147 mi^2) in northeastern Minnesota. It includes the area designated as critical habitat in 2014 (79 FR 54782) and an additional relatively small area of tribal land that was excluded from critical habitat. Land ownership in this unit is about 47 percent Federal (primarily USFS, with some NPS and BLM land); 36 percent State; 16 percent private; and 1 percent Tribal (Grand Portage Reservation; see table 2). This unit includes most of Superior National Forest (SNF; including the Boundary Waters Canoe Area Wilderness [BWCAW]) and Voyageurs National Park. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario. Relative to other DPS lynx populations, this unit is about 1,610 km (1,000 mi) west of the Northern Maine geographic unit and about 1,480 km (920 mi) east of the Northwest Montana/Northeast Idaho Unit.

Habitat Description: In Minnesota, most lynx occurrences are associated with the Mixed Deciduous/Conifer Forest (McKelvey *et al.* 2000a, pp. 246, 248) within the Laurentian Mixed Forest Province (McNab *et al.* 2007, p. 5). Most of this province is characterized by low-relief hilly landscapes with glacial features and an elevation from sea level to 730 m (2,400 ft), including many lakes and rivers. This unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps and black spruce or tamarack bogs. Coniferous and mixed-coniferous/deciduous vegetation types are dominated by balsam fir; black and white spruce (*Picea glauca*); northern white cedar (*Thuja occidentalis*); Jack (*Pinus banksiana*), white, and red (*Pinus resinosa*) pine; eastern hemlock (*Tsuga canadensis*); and tamarack; mixed with aspen and paper birch (Burdett 2008, p.5; McCann and Moen 2011, p. 510). Burdett (2008, p. 57) reported that lynx in Minnesota selected regenerating forest, dominated by conifer with extensive forest edge, and that lynx beds (resting and hunting) and kill sites were associated with regenerating and mixed forest. McCann and Moen (2011, p. 513) found snowshoe hare densities were highest in regenerating forests. Female lynx selected large woody debris and dense horizontal cover in lowland conifer cover for denning in northern

Minnesota (Moen *et al.* 2008a, p. 1510), but other cover types were used if recent blowdowns were present (Moen and Burdett 2009, p. 5).

Snowshoe hare habitat in Minnesota primarily consists of conifer forests with dense low-growing understories, lowland shrub, and conifer bogs. Conifer bogs or lowland conifer forests may be especially important during declines in hare abundance by acting as refugia for hares. Early regenerating or pole-sized stands are not used as much as in other portions of their range, although older regeneration stands were used frequently in Minnesota (McCann 2006, p. 45). Sapling-sized aspen adjacent to conifer cover may also provide functional snowshoe hare habitat. In northeastern Minnesota, edge habitats and regenerating conifer stands appeared to be important for snowshoe hare populations (Burdett 2008, p. 58; McCann 2006, p. 45), as were dense habitats containing balsam fir, white spruce, and cedar (Fuller and Heisey 1986, p. 263). Recent research indicates that the red squirrel is not an important prey species for lynx in northeastern Minnesota (Burdett 2008, p. 62; Hanson and Moen 2008, p. 9).

Average annual snowfall in this unit ranges from about 180 cm (71 in) in the northwestern part of the unit near International Falls, to 219 cm (86 in) in Duluth, on the southern end of the unit, to 228 cm (90 in) in Tofte, near the lake shore on the far eastern-central part of the unit and in Isabella, near the center of the unit, to 107 cm (42 in) in Grand Portage, at the northeastern tip of the unit. More snow is produced along Lake Superior, because of the lake effect[17].

Habitat Status: Friedman and Reich (2005, p. 732) conducted a spatially explicit forest composition change analysis on a 3.2 million-ha study area in northeastern Minnesota, which was based on General Land Office Survey records from the late 1800s and the 1990 USFS Inventory and Analysis Survey. The study documents altered forest tree species abundance, proportional basal area, and spatial distribution patterns. The proportionally most abundant species in northeastern Minnesota shifted from the presettlement period (spruce, 21 percent; tamarack, 15 percent; and paper birch, 15 percent) to aspen (30 percent), spruce (16 percent), and balsam fir (16 percent) in 1990. White pine declined from 20 percent to 5 percent basal area dominance, birch from 16 percent to 13 percent, spruce from 14 percent to 9 percent, and tamarack from 12 percent to 2 percent, while aspen increased from 8 percent to 35 percent basal area dominance.

The SNF continues to manage in accordance with its 2004 Forest Land and Resource Management Plan (USFS 2004a, entire). The Forest Plan emphasizes providing sustainable amounts of timber, maintaining or enhancing biodiversity, contributing to economic and social needs of the community, and managing in an environmentally sound manner to produce goods and services that provide for long-term public benefits. The Plan includes many objectives, standards, and guidelines for the protection of lynx and enhancement of lynx habitat (USFS 2004a, Appendix E) that are based on recommendations in the 2000 LCAS (Ruediger *et al*. 2000, entire). LAUs were delineated on the SNF in 2000 as the smallest landscape scale on which to analyze effects to lynx. The boundaries have remained in place since that time to allow for long term analysis of project effects. However, the SNF Plan proposed several changes of

[17] https://snowfall.weatherdb.com/d/a/Minnesota; accessed 4/25/2016.

current LAU boundaries, such as adding LAUs to the Virginia Management Unit of the Laurentian Ranger District, and designating the BWCAW a lynx refugium.

Hare density in parts of northeastern Minnesota appears to be sufficient to support a viable lynx population (Moen *et al.* 2008a, p. 1512), with stand-level densities ranging from 0.3–2.0 hares/ha (0.12–0.8 hares/ac; McCann 2006, p. 17). Hare populations in northeastern Minnesota appear to be patchily-distributed, but are most consistently abundant in 10-30 year old regenerating forests (McCann 2006, p.45). Pellet count data prior to the 1990s show evidence of density fluctuations of snowshoe hare populations occupying Minnesota (Fuller and Heisey 1986, pp. 262-263), but these fluctuations were not observed during the 1990s (Hodges 2000a, p. 172).

This unit is directly connected to lynx habitats and populations in southern Ontario, where trapping of lynx is legal. Habitat connectivity within and between portions of northeastern Minnesota and Canada appears functional based on radio-telemetry data that have documented lynx movements in both directions between Minnesota and Ontario (Burdett *et al.* 2007, p. 458; Moen 2009, pp. 4-6; Moen *et al.* 2010b, p. 5).

Lynx Status: When the DPS was listed, it was uncertain whether a resident lynx population occurred in Minnesota. However, we now know that a reproducing resident population has persisted in Unit 2 since the DPS was listed. Moen *et al.* (2008b, p. 30) estimated a likely maximum (all available habitat occupied) number of 190-250 resident lynx in this unit, and Moen (*in* Lynx SSA Team 2016a, p. 39) recently suggested that the resident population likely fluctuates from about 50 to 200 lynx. A more precise estimate of resident population size is not available.

Average home range sizes in Minnesota were first reported as 194 km^2 (75 mi^2) for males and 87 km^2 (34 mi^2) for females (Mech 1980, p. 263). Later radio-telemetry data showed that males had much larger average home range sizes (267 km^2 [103 mi^2]) than females (21 km^2 [8 mi^2]), and that females with kittens had the smallest home ranges (Burdett *et al.* 2007, pp. 460-461). A study of radio-collared lynx in Minnesota documented approximately 40 percent of male and female lynx making long distance movements outside of their home ranges and into southern Ontario (Moen *et al.* 2010b, p. 17). Among lynx that made long-distance movements, females tended to move 100-200 km (62-124 mi) and did not return to their original home ranges in Minnesota, while males moved 50-80 km (31-49 mi) back and forth between Ontario and Minnesota (Moen *et al.* 2010b, p. 17).

The SNF and others have identified 268 unique individual lynx (48 percent female, 51 percent male) from DNA samples taken since 2000 (Catton *et al.* 2015, p. 1). This study also documented lynx hybridization with bobcat and identified 13 unique individual lynx-bobcat hybrids (5 Female, 8 Male; Catton *et al.* 2015, p. 1). The DNA analyses also showed persistence of individual lynx in Minnesota of 2 years (N = 27 lynx), 3 years (N = 11), 4 years (N = 5), 5 years (N = 6), and 1 female lynx tracked for over 5 years, who produced 7 kittens in Minnesota (Catton *et al.* 2015, pp. 3-5).

Since 2000, the Service has documented 45 lynx mortalities in Minnesota including 16 that died of unknown causes, 11 that died after being incidentally captured in traps set for other species, 9 that were hit by vehicles on roads, 7 that were illegally shot, and 2 that were hit by trains (USFWS 2016b, *unpubl. data*). In addition to the 11 trapping mortalities, another 15 lynx were documented to have been incidentally trapped but released alive. The documented incidents largely occurred during legal trapping that targeted bobcat, coyote, fox, and marten, and involved a variety of traps including foot-holds, body gripping traps, and snares. Other lynx may have been incidentally trapped but not reported. Additionally, lynx emigrating from Minnesota to Ontario are exposed to legal trapping and shooting in accordance with regulated harvest in Canada. At least a third of lynx radio-collared in Minnesota spent time in Ontario; 4 radio-collared lynx were legally harvested (trapped) in Canada between 2003 and 2010, and 2 died in Ontario of unknown causes (USFWS 2016b, *unpubl. data*). Some of these mortalities occurred years after the lynx was last located in Minnesota, indicating, along with evidence of lynx returning to Minnesota after dispersing to Ontario, that survival of Minnesota lynx in Ontario for extended periods is possible (Moen 2009, pp. 2-3, 10-13). Minnesota has relatively high forest road and highway densities that intersect lynx habitat and several radio-collared lynx in Minnesota inhabited home ranges that were bisected by highways.

Factors Affecting Current Conditions

Identified factors potentially affecting current conditions for lynx in Minnesota include reduction in habitat quality or quantity, habitat fragmentation, climate change, increased access for competing hare predators, and human-caused mortality. The SNF is currently implementing the 2004 SNF Plan (USFS 2004a, entire), which has direction based on the LCAS (Ruediger et al. 2000, entire) and the Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (USFS and USFWS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can create, maintain, and restore lynx habitat, and the SNF has a long-term commitment for doing so; however, private landowners do not. Under the Sustainable Forest Resource Act of 1995, the Minnesota Forest Resources Council (MNFRC) has developed guidelines for site-level timber harvesting and forest management (MNFRC 2012, p. 1); these voluntary guidelines are intended for private and State landowners and include some general recommendations for wildlife including lynx. The implementation of the MNFRC guidelines is monitored annually (e.g., MNDNR 2016b, p. 2). Thus, the several risk factors are being minimized and managed to promote the conservation of lynx within the SNF, however implementation of the guidelines on privately owned lands is voluntary.

Activities that change forest structure can affect habitat quantity and quality for lynx and snowshoe hares, their primary prey source. Thinning and other timber management practices that reduce stem density and downed material and promote more open, mature stands can reduce habitat quality and quantity. Throughout the SNF and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Mineral exploration and development is increasing in portions of

Minnesota, particularly for hard rock (non-ferrous) minerals. Some of the area of interest for minerals overlaps with lynx habitat in northeastern Minnesota. Mineral exploration may result in short-term displacement of lynx. Mining activities and associated development may result in an irreversible loss of habitat or increased mortality risk. The specific effects to lynx and their habitat will depend on the scale and type of each project.

Roads are a factor in human-caused lynx mortality where they provide access to areas where lynx occur, increasing the risk of negative interactions between people and lynx. Throughout the SNF outside the BWCAW, high and low standard roads bisect many areas that provide potential or suitable lynx habitat. Additionally, bobcat harvest in northeastern Minnesota has been increasing over the last decade (Erb 2012, unpaginated), although it is still very rare in the area occupied by resident lynx in this unit. Where lynx and bobcat overlap, there is potential for accidental shooting and increased incidental trapping of lynx.

Winter road use, snowmobiling, cross country skiing, and dog sledding all increase the amount and distribution of compacted snow conditions, which may increase access by potential lynx competitors or predators to snowy areas from which they may otherwise be excluded (ILBT 2013, pp. 80-82). However, results of research on whether these activities result in increased competition or predation are ambiguous (ILBT 2013, p. 81) and impacts, therefore, are uncertain. Outside the BWCAW, snowmobile activity is extensive and increasing significantly. The SNF has 1,135 km (705 mi) of snowmobile trails and 2,514 km (1,562 mi) occur on all ownerships within the National Forest boundary (USFS 2011a, p. 38). Advances in snowmobile capabilities have raised concerns about intrusion and snow compaction in areas previously not vulnerable to high levels of snowmobile use. In addition, new road construction in lynx habitat has made more areas accessible during winter. These routes could be used by snowmobiles even if new roads are designated as closed to motorized public travel during other seasons. The SNF has 3,101 km (1,927 mi) of low standard roads and 254 km (158 mi) of temporary roads (USFS 2011a, p. 38). Increases in these activities have the potential to reduce the competitive advantage lynx are believed to have in areas that typically receive deep, persistent, unconsolidated snows.

As described in Chapter 2, lynx are adapted for surviving in areas that have cold winters with deep, fluffy snow, where they are thought to outcompete potential competitors such as bobcats, coyotes, and wolves. The geographical distribution of bobcat harvest in Minnesota has remained relatively static with a lack of harvest in the Arrowhead Region of Minnesota (the region encompassed by Cook, Lake, and St. Louis counties in northeastern Minnesota; Erb 2009 cited in Kapfer 2012, p. 16; Erb 2012, unpaginated) and annual snow track and scent stations surveys support the conclusion that bobcats are as rare in the Arrowhead Region as harvest indicates (MNDNR, *unpubl. data*, cited in Kapfer 2012, p. 23). However, this may change with decreased snow conditions predicted to result from continued climate warming (Kapfer 2012, p. 25; see section 5.2.2). Bobcat and coyote populations already appear to be increasing in Minnesota (Erb 2014, p. 40). If snow depth and duration decrease in the Arrowhead Region as projected by climate models, deer mortality may be reduced; this could increase bobcat densities and facilitate bobcat expansion into northeastern Minnesota (Kapfer

2012, p. 25), potentially increasing bobcat-lynx hybridization (Koen *et al.* 2014b, p. 113). According to annual track surveys, wolf populations in Minnesota are currently stable (Erb 2014, p. 40); however, similar to bobcat, wolf populations may increase with changing snow conditions and prey availability as influenced by climate change.

In summary, although lynx residency in the unit was uncertain when the DPS was listed, we now understand that it supports a persistent resident population that is thought to fluctuate from 50-200 individuals, likely in response to hare population changes that affect lynx survival, productivity, and recruitment. We have no evidence to suggest that this area historically supported a larger population or a broader distribution of habitat capable of supporting persistent lynx occupany. Although recent research has improved our understanding of lynx distribution, habitat requirements, dispersal, and some demographic parameters in this unit, we still lack information on kitten survival, recruitment, and the influence of immigration and emigration on population persistence.

4.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Unit Description: This geographic unit includes the parts of northwestern Montana and northeastern Idaho the Service designated as critical habitat for lynx in 2014 and some Tribal and State lands that were excluded from that designation (79 FR 54825). It encompasses approximately 27,000 km^2 (10,424 mi^2) in portions of Boundary County in Idaho and Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton Counties in Montana. Ownership in this unit is 84 percent Federal (USFS, NPS, and BLM); 8 percent private; 4 percent State; and 4 percent Tribal. Most Federal lands in this unit (82 percent) are on national forests managed by the USFS; with NPS (16 percent) and BLM (almost 2 percent) contributing most of the remainder. This unit includes most of Glacier National Park and parts of the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo National Forests, the BLM's Garnet Resource Area, and the Confederated Salish and Kootenai Tribes Flathead Reservation. It also includes (from northwest to southeast) all or parts of the Purcell, Cabinet, Salish, Whitefish, Lewis, Flathead, Swan, and Garnet mountain ranges. Several areas adjacent to this unit are known or thought to support a small number of resident lynx, at least intermittently, including the southern Selkirk Mountains of northern Idaho and northeastern Washington and the western Cabinet Mountains of northern Idaho (USFS 2015a, pp. 9-10; Lucid 2016, pp. 7-11; Lucid *et al*. 2016, pp. 158-160; IDFG 2017, pp. 2-5), and a small area of the Helena National Forest just south of MacDonald Pass, between Helena and Missoula (Gehman *et al.* 2011, p. 21). This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit may represent the southern extent of a larger cross-border population that also occurs in southwestern Alberta and southeastern British Columbia. Relative to other DPS lynx populations, this unit is about 200 km (125 mi) east of the north-central Washington unit, about 145 km (90 mi) northwest of the GYA, and about 1,480 km (920 mi) west of the Northeastern Minnesota geographic unit.

Habitat Description: In the Northern Rocky Mountains, most lynx occurrences are associated with the Rocky Mountain Conifer Forest or Western Spruce-Fir Forest vegetative classes

(Kuchler 1964, p. 4; McKelvey *et al.* 2000a, p. 246) at elevations ranging from 1,250 m (4,100 ft) to 2,500 m (8,200 ft; Aubry *et al.* 2000, pp. 378–380; McKelvey *et al.* 2000a, pp. 243–245). The dominant vegetation that constitutes lynx habitat in these areas is subalpine fir, Engelmann spruce and lodgepole pine (Aubry *et al.* 2000, p. 379; Ruediger *et al.* 2000, pp. 4-8 - 4-10). Within these vegetation types, lynx appear to prefer areas of moderate to gentle topographic relief (Koehler and Aubry 1994, p. 86; Apps 2000, p. 352; Squires *et al.* 2013, pp. 187, 191). Lynx use large landscapes that include a temporally- and spatially-shifting mosaic of forest age classes, where natural or anthropogenic disturbances may reset forest succession (ILBT 2013, p. 28). Early successional stages that often provide dense horizontal cover at ground/snow level and support high hare densities (Griffin 2004, pp. 53-54, 70; Squires *et al.* 2010, pp. 1654-1656) may be created and maintained by natural disturbance processes including wildfire, insect infestations, tree diseases, and wind events (ILBT 2013, p. 28). Timber harvest, other silvicultural treatments, wildfire management, or other vegetation management, which may be beneficial, benign, or adverse to lynx and hare habitats depending on prescription, extent, and implementation, can also influence the amount and distribution of early successional stands (Agee 2000, p. 39; ILBT 2013, pp. 28, 71-76). Likewise, natural disturbance regimes and forest management can also influence the amount and distribution of mature multi-story spruce-fir stands, which can include dense horizontal structure, support high hare densities (Griffin 2004, pp. 53-54, 70; Squires and Ruggiero 2007, pp. 313-314; Berg *et al.* 2012, pp. 1483-1485), and provide preferred winter foraging habitat for lynx (Squires *et al.* 2010, pp. 1653-1657).

In northwestern Montana, lynx generally occur in mid-elevation (1,260 – 2,355 m [4,130 – 7,730 ft]) moist subalpine mixed-conifer forests dominated by Engelmann spruce and subalpine fir and including Douglas-fir, western larch (*Larix occidentalis*), and lodgepole pine (Squires *et al.* 2010, pp. 1653-1654). Lynx home ranges occur in areas with low surface roughness (i.e., low topographic relief; gently-sloping to moderately-steep terrain), high canopy cover indices, and little open grassland (Squires *et al.* 2013, p. 191). These lynx habitats occur below the alpine zone and above drier, more open forest types (e.g., ponderosa pine and dry Douglas-fir/western larch/lodgepole pine) that do not provide lynx habitat (Agee 2000, p. 42; Berg 2009, p. 20; Squires *et al.* 2010, p. 1655). As elsewhere in the western portion of the DPS, this elevational pattern contributes, along with the transition from boreal to more temperate forests, to a naturally patchier, more fragmented distribution of lynx habitat than in the continuous boreal forest landscape in the core of the lynx's North American range in northern Canada and interior Alaska (65 FR 16052-53; 68 FR 40089; Squires *et al.* 2006[a], pp. 46-47; ILBT 2013, pp. 76-77; Squires *et al.* 2013, p. 191; 78 FR 59438). Squires *et al.* (2013, pp. 187-189) used telemetry data to model the distribution of probable lynx habitat in a 36,096-km^2 (13,937-mi^2) study area that completely overlaps this geographic unit. Their results indicate that much of the area has a low to moderate probability of selection by lynx, and that the areas with higher selection probabilities are relatively small and patchily- but widely-distributed throughout the unit and are separated by intervening areas of low probability of lynx use (Squires *et al.* 2013; see fig. 1(a), p. 189). Holbrook *et al*. (2017, entire) recently corroborated this result. This patchy distribution of high-quality habitats interspersed with areas of low-quality or non-habitat results in naturally lower densities of both snowshoe hares and lynx than those typical (except durig hare cycle lows) in the continuous boreal forests of northern Canada and Alaska (Wolff 1980, pp. 123–128;

Buehler and Keith 1982, pp. 24, 28; Koehler 1990a, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373–375, 382, 394).

In this unit, female and male lynx exhibit strong selection for advanced (25- to 40-year-old) regenerating spruce-fir stands in both winter and summer and at all levels of proportional availability (ranging from about 5 to 40 percent) of this stand type on the landscape (Holbrook *et al*. 2017, pp. 10-18 and fig. 6). In winter, females and males both preferentially use mature multi-story spruce-fir stands with dense horizontal cover, particularly when it is less available, proportionally, on the landscape, and they avoid clearcuts and large forest openings (Squires *et al.* 2010, pp. 1648, 1653–1656; Holbrook *et al*. 2017, pp. 10-18 and fig. 6). In summer, lynx also select young stands with dense spruce-fir saplings, avoid mature forest, do not appear to avoid openings as in winter, and use slightly higher elevations (Squires *et al.* 2010, pp. 1648, 1653–1656; Holbrook *et al*. 2017, pp. 13, 18). Both mature multi-story and young regenerating stands provide dense horizontal structure at ground/snow level, which supports higher snowshoe hare densities than more open young or mature forests. In the central (Seeley Lake study area) part of this unit, during an apparent regional hare decline in 1999-2001, summer hare densities were highest (up to 1.4 hares/ha [0.6 hares/ac] in 1 study area) in dense young stands, and winter densities were highest (up to 1.8 hares/ha [0.7 hares/ac] in 1 study area) in dense mature stands (Griffin and Mills 2009, pp. 1492-1496). Over a longer interval (1999-2003) when hare populations in this area were thought to be stable, mean summer and winter hare densities, respectively, were 0.34 and 0.53 hares/ha (0.14 and 0.21 hares/ac) in dense mature stands and 0.64 and 0.47 hares/ha (0.26 and 0.19 hares/ac) in dense young stands – habitats selected by lynx, compared to 0.18 and 0.20 hares/ha (0.07 and 0.08 hares/ac) in open mature stands and 0.18 and 0.12 hares/ha (0.07 and 0.05 hares/ac) in open young stands that lynx did not select (Squires and Ruggiero 2007, pp. 313-314). Even the relatively higher hare densities in the dense young and dense mature stands only marginally achieve the threshold density of 0.5 hares/ha (0.2 hares/ac) thought necessary to support lynx within home ranges (Ruggiero *et al.* 2000b, pp. 446–447; ILBT 2013, pp. 24, 26, 90; also see section 2.2.1). Nonetheless, hares accounted for 96 percent of the biomass in lynx diets in this unit based on evidence at kill sites (Squires and Ruggiero 2007, pp. 310-313), suggesting that even small declines in landscape-level hare densities could reduce the ability of habitats in this unit to support resident lynx (Squires *et al.* 2010, p. 1656).

Lynx in this unit generally den in mature spruce-fir forests among downed logs or root wads of wind-thrown trees in areas with abundant coarse woody debris and dense understories with high horizontal cover in the immediate areas around dens (Squires *et al.* 2004a, table 3; Squires *et al.* 2008, pp. 1497, 1501–1505). Dens are located farther from forest edges than random expectation are few occur in young regenerating or thinned stands with discontinuous canopies (Squires *et al.* 2008, p. 1497).

Average annual snowfall in this unit ranges from about 142 cm (56 in) in the Kalispell/Whitefish/ West Glacier area of northwestern Montana to 183 cm (72 in) in Nordman in northern Idaho, to 216 cm (85 in) in Lincoln, Montana, near the southern end of the unit, to 259 cm (102 in) in Rexford, Montana near the Canada-United States border, to 345 cm (136 in) in Seeley Lake,

Montana, in the central part of the unit, with most snow falling from November to March in each place[18].

Habitat Status: Most lynx habitat in this unit is currently designated as critical habitat in accordance with the ESA. Over 84 percent (22,761 km^2 [8,788 mi^2]) of this unit is in Federal ownership, including 18,695 km^2 (7,218 mi^2) in national forests under USFS management, 3,658 km^2 (1,412 mi^2) in Glacier National Park managed by NPS, and 397 km^2 (153 mi^2) managed by BLM in its Garnet Resource Area. As described above, potential lynx habitat in this unit is patchily-distributed and interspersed with areas of non-habitat (matrix). Among the 6 national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 54 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123). In Glacier National Park, 2,976 km^2 (1,149 mi^2; about 73 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 1,103 km^2 (426 mi^2; 27 percent of the park, 37 percent of lynx forest types) is estimated to be lynx habitat (68 FR 40086, 40089). In the Garnet Resource Area, the BLM designated 5 LAUs (which approximate a lynx home range) covering 947 km^2 (366 mi^2), of which, 574 km^2 (222 mi^2; about 61 percent) was mapped as lynx habitat (Sparks 2016a, *pers. comm.*).

Federal lands are managed as either ''developmental'' or ''nondevelopmental'' land use allocations (68 FR 40093). Lands in developmental allocations are managed for multiple uses, such as recreation and timber harvest, some of which may conflict with lynx conservation. Management within non-developmental allocations focuses on the maintenance of natural ecological processes, or conservation of rare ecological settings or components, and these areas include wilderness, roadless, and semi-primitive non-motorized areas (USFWS 2007, pp. 33, 77). Timber harvest, road construction, and fire suppression typically do not occur or are very limited in lands managed in non-developmental allocations.

In this SSA unit, almost 46 percent of the Federal land and 40 percent of the entire unit is in designated wilderness or National Park land. This includes (in addition to Glacier National Park) the 6,297-km^2 (2,431-mi^2) Bob Marshall Wilderness Complex (Bob Marshall, Great Bear, and Scapegoat wilderness areas) on the Flathead, Lewis and Clark, Helena and Lolo National Forests; the 302-km^2 (117-mi^2) Mission Mountain Wilderness on the Flathead National Forest; the 139-km^2 (54-mi^2) Rattlesnake Wilderness Area on the Lolo National Forest; and the 371-km^2 (143-mi^2) Mission Mountain Tribal Wilderness on the Flathead Reservation. Management of NPS lands and both national forest and Tribal wilderness areas provides land-use restrictions that are likely beneficial to lynx (65 FR 16073; USFWS 2014, pp. 28-29; 79 FR 54831), and adverse effects of management activities on lynx habitats in these areas are unlikely. Among the 6 national forests that contribute to this unit, 56 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34).

Much of the remaining USFS lands and the BLM lands have developmental land-use allocations where some management activities have the potential to impact lynx or its habitat. However, as described above in section 3.1.1, USFS lands in this unit are managed in accordance with the

[18] https://snowfall.weatherdb.com/d/a/Montana; accessed 4.2.2016.

NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2004 amended the Resource Management Plan (RMP) for the Garnet Resource Area to incorporate the conservation measures identified in the LCAS (BLM 2004a, 2004b, entire; Sparks 2016b, *pers. comm.*). Both documents provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently applied framework for conserving and restoring important hare and lynx habitats.

Habitat status on private lands, which account for about 8 percent of lands in this unit (2,172 km^2 [839 mi^2]), is governed by some Federal and State regulations and by a number of private-public conservation partnerships and State agency efforts. As described in section 3.1, some Federal and State regulations guide some activities on private lands, including the ESA's prohibition on take of listed species, and State regulations governing trapping and timber management. In addition to these protections, there have been several other notable lynx conservation achievements on private lands in this unit since the DPS was listed. Two of these, the Clearwater-Blackfoot Project and the Montana Legacy Project, are multi-partner and community efforts led by The Nature Conservancy in Montana to purchase large tracts of private commercial timberlands, conveying some to the State of Montana and the USFS for conservation management, and acquiring conservation easements on others (TNC 2016a, 2016b, 2016c, entire). These land acquisitions have resulted in protection of roughly 673 km^2 (260 mi^2) of important lynx habitat within this SSA unit and another 583 km^2 (225 mi^2) just to the south and west that may occasionally or temporarily support lynx or provide dispersal habitat. Additionally, the MTFWP has acquired fee title or conservation agreements on 3,096 km^2 (1,195 mi^2) of private lands in western Montana, including 162 km^2 (63 mi^2) in designated lynx critical habitat in this SSA unit, with ongoing efforts on another 106 km^2 (41 mi^2) in the northwest part of the unit (MTFWP 2016, pp. 1, 3).

In addition to the MTFWP's efforts to acquire private lands and protect them through fee title or conservation agreement, the State of Montana has also worked to protect lynx habitat on State-owned lands, which account for about 4 percent of the lands in this unit (1,106 km^2 [427 mi^2]). As described above in section 3.1.2, the MTDNRC worked closely with the Service to develop the *State of Montana Department of Natural Resources and Conservation Forested State Trust Lands Habitat Conservation Plan* (MTDNRC HCP; MTDNRC and USFWS 2010a, 2010b, 2010c, entire); a multi-species HCP that focuses primarily on commercial forest management. The HCP includes a Lynx Conservation Strategy that minimizes impacts of forest management activities on lynx, describes conservation commitments that are based on recent information from lynx research in Montana, and commits to active lynx monitoring and adaptive management programs. The HCP covers about 2,220 km^2 (857 mi^2) of forested State trust lands in western Montana, including 703 km^2 (271 mi^2) within this SSA geographic unit (about 64 percent of State lands in this unit). The goal of the HCP's Lynx Conservation Strategy is to

support Federal lynx conservation efforts by managing for habitat elements important to lynx and their prey that contribute to the landscape-scale occurrence of lynx. Specific objectives to achieve this goal include protecting den sites and potential denning habitat, mapping and maintaining lynx foraging habitats and limiting the spatial and temporal scope of their conversion to unsuitable conditions from forest management activities, and providing for habitat connectivity (MTDNRC and USFWS 2010b, pp. 2-45 - 2-61). The HCP was finalized and permitted by the Service in 2011, and includes a 50-year commitment by the State to manage for lynx conservation on these lands (79 FR 54835-37).

Tribal lands of the Flathead Reservation account for almost 4 percent of this unit. In addition to the Tribe's approach to lynx management described in section 3.1.2, most lynx and lynx habitat on the reservation occur in areas with formal protective status, including: (1) The long-designated Mission Mountains and Rattlesnake Tribal Wilderness Areas, which are largely roadless and managed for wilderness qualities; (2) the South Fork/Jocko Primitive Area, which is open to use only by Tribe members and in which commercial timber harvest is prohibited; and (3) the Nine-mile Divide country, which is marginal in terms of lynx habitat, but which is also partly roadless (Courville 2014, *pers. comm.*; 79 FR 54831).

As elsewhere in the DPS, winter foraging habitat is thought to be the most limiting habitat for lynx in this unit (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27). As described above, lynx selected mature multi-story stands with dense horizontal structure and relatively higher winter hare densities (Squires *et al.* 2010, pp. 1648, 1653–1656). Because of this preference, the Forest Service in the NRLMD adopted a vegetation management standard (VEG S6) that precludes all vegetation management activities that could reduce winter snowshoe hare habitat in multi-story forests, not just precommercial thinning as recommended in the LCAS (USFS 2007, pp. 13-14). Also as elsewhere (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517, ILBT 2013, p. 30; 79 FR 54790), denning habitat is not thought to be a limiting factor for lynx in this unit (Squires *et al.* 2008, p. 1505). Nonetheless, the NRLMD includes guidance to ensure adequate denning habitat remains well distributed in LAUs and, therefore, across the larger landscape and to design projects to create or retain coarse woody debris in areas where denning habitat may be lacking (USFS 2007, p. 17). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous United States from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled snow suitability across North America, showing that this geographic unit currently has a 90-95 percent probability of providing snow cover consistent with historical lynx occurrence records (Gonzalez *et al.* 2007, p. 12).

Overall, although naturally fragmented and patchily-distributed, lynx habitat in this geographic unit appears to be largely intact relative to historical conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway) development and evidence of minor

genetic differentiation among lynx subpopulations (see *Lynx Status*, below), past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

A possible exception may be in the Garnet Mountains, which are known to have supported a small number of resident lynx in the 1980s and recently from 2002-2010, but where more recent surveys and research trapping efforts failed to detect lynx from 2011 to 2015 before a single lynx was verified in 2016 (Squires *in* Lynx SSA Team 2016a, p. 20; Lieberg 2017, *pers. comm.;* also see Lynx Status, below). This small and relatively isolated island of lynx habitat (Squires 2014, p. 4) at the southern end of this unit is thought to be capable of supporting 7-10 lynx home ranges (Squires 2016, *pers. comm.*). The BLM (2004, pp. 4-5) contrasted current and historical distributions of lynx habitats in the Garnets and found that early-successional stands (future hare and lynx foraging habitats) were at 25-50 percent of the historical condition in lower-elevation (1,370-1,830 m [4,500-6,000 ft]) lynx habitats, and 10-30 percent in higher-elevation (1,675-2,130 m [5,500-7,000 ft]) habitats. Late-successional (mature multi-story) stands (25-75 percent of historical condition) and large (> 100 ha [250 ac]) patches (25-50 percent of historical condition) were also underrepresented at lower elevations, but at higher elevations, these 2 stand types exceeded 200 percent and 100 percent of historical conditions, respectively. Lower elevation habitats were fragmented by roads and past management practices (i.e., timber harvest), while higher-elevation habitat patterns were attributed to the absence of disturbance, including fire (BLM 2004, p. 5), though fire absence was not attributed to suppression.

As discussed for the GYA in section 2.3.2.2, whether the recent absence of resident lynx in the Garnets represents the extirpation of a previously-persistent small population (and, therefore, a contraction in the range of resident lynx in this unit) or a temporary “winking off” of a naturally ephemeral small peripheral population, as might be expected in a mainland-island metapopulation structure, is uncertain and perhaps irresolvable. If residency was intermittent or ephemeral historically, the current absence of resident lynx might be a natural condition related to the area’s naturally fragmented habitats and generally low hare densities - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. If so, future intermittent lynx occupancy would be expected, but only if lynx dispersing from a source population immigrate to the Garnets when habitat conditions and hare densities return to more favorable levels. Conversely, if the Garnets historically supported a small but persistent population that was recently extirpated, it may suggest that the alteration of the historical distribution of some habitats in some parts of the range, described above, was enough to shift the quality of the area’s habitat from capable of supporting a small resident population to no longer capable of doing so.

In summary, almost all lands in this unit are managed to conserve lynx and hare habitats in accordance with Federal, State, and Tribal regulations and management direction, conservation easements, and an approved HCP. Much of the area consists of designated Federal and Tribal wilderness areas and other nondevelopmental land use allocations, where management activities with the potential to adversely affect lynx generally do not occur. On lands with development allocations, USFS, BLM, and State management are based on plans that

incorporate the conservation guidance identified in the LCAS as informed by more recently available scientific information. The State and TNC, working with other conservation partners, have bought or acquired conservation easements on large tracts of high-quality private lands in the unit that are known or suspected to be occupied by resident lynx. These efforts and management across multiple ownerships likely preclude landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places, as described above for the Garnet Mountains. Because lynx habitats in this unit, like most other areas of the DPS range, are naturally highly-fragmented, and most have hare densities that barely meet the 0.5 hares/ha (0.2 hares/ac) threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historical or current number of resident lynx in this unit although, as described in section 2.3.2.2 above, it is thought to be capable of supporting perhaps 200-300 lynx (Squires *in* Lynx SSA Team 2016a, p. 41). This is substantially fewer than previous estimates of more than 1,000 lynx, which were based on a habitat area/ density index and broad assumptions regarding habitat suitability and lynx distribution (65 FR 16058) that are not supported by current understanding of lynx habitat requirements and current or historic habitat availability in this unit. That is, based on our understanding of lynx habitat and its current and historical distriubtution, it is very unlikely that this unit and surrounding areas were ever (recently or historically) capable of supporting 1,000 resident lynx. As described above, habitats capable of supporting resident lynx in this unit are (and also were historically) naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016a, p. 12). Although the exact distribution of resident lynx remains uncertain, this unit has a long and continuous history of lynx occurrence and evidence of reproduction (McKelvey *et al.* 2000a, pp. 224-225; Squires and Laurion 2000, pp. 346-348; Squires *et al.* 2008, entire; Squires *et al.* 2013, entire; ILBT 2013, p. 57; 65 FR 16058; 68 FR 40090; 74 FR 8643; 79 FR 54825). Genetic analyses revealed minor fine-scale genetic sub-structuring among lynx subpopulations in the southern (Garnet Mountains), central (Seeley Lake), and northern (Purcell Mountains) parts of this unit, suggesting limited interaction among lynx in those areas (Schwartz *in* Lynx SSA Team 2016a, p. 12 and Appendix 5; Squires *in* Lynx SSA Team 2016a, p. 20). Lynx in this unit likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia, but the extent to which lynx persistence in this area may rely on immigration from Canada is unknown, and there is no indication of substantial immigration (irruptions) of lynx from Canada into this unit after the 1980s (Squires *in* Lynx SSA Team 2016a, p. 20).

From 1998 to 2007, researchers with the Forest Service's Rocky Mountain Research Station (RMRS) in Missoula trapped and radio-marked 175 lynx in northwestern Montana and collected nearly 170,000 GPS and over 3,000 VHS telemetry locations documenting lynx movements, resource use, survival, and productivity (Squires *in* Lynx SSA Team 2016a, p. 20). From 1999-

2007, litter sizes averaged 2.24 kittens/litter (N = 33) in the Seeley Lake area and from 2003-2007, 2.95 kittens/litter (N = 22) in the Purcell Mountains. In Seeley Lake, 61 percent of breeding-age females (N = 52) produced kittens; in the Purcells, 83 percent of females (N = 28) produced kittens. Recent research (Kosterman 2014, entire) suggests that the probability that a female produces a litter and initial litter size are correlated positively with mature forest connectivity and negatively with fragmentation in female home ranges (Squires *in* Lynx SSA Team 2016a, p. 20 and Appendix A). Annual survival rates for subadult and adult female lynx were 0.52 and 0.75, respectively, in Seeley Lake, and 0.68 and 0.85, respectively, in the Purcells. Kitten survival rate was 0.58 in Seeley Lake (Kosterman 2014, pp. 13, 30). There was no evidence of cyclicity in these vital rates, and no indication of substantial immigration of lynx into these study areas from Canada. Starvation, predation by cougars, and human-caused deaths each accounted for roughly one-third of documented sources of lynx mortality. Population viability analyses yielded population growth rates (λ) of 0.92 for the Seeley Lake area (i.e., declining population trend, 1999-2007) and 1.16 for the Purcells (increasing trend, 2003-2007). However, as described in section 2.2.2, estimates of λ in a cyclic Canadian population of lynx ranged from 2.03 (annual doubling) when hares were abundant to 0.10 (order of magnitude decline) after hare populations crashed (Slough and Mowat 1996, p. 952, table 4), and the natural range in λ that would be expected among peripheral, isolated, or semi-isolated and non-cyclic or weakly-cyclic lynx populations in the DPS versus those that would signal long-term population decline or instability is unknown. Also as noted above, estimates of λ in this unit assumed no immigration, which is a questionable assumption, and only low numbers of immigrants (less than 1 female/yr on average for a hypothetical population of 100 lynx) would be needed to provide population stability or even growth (Schwartz 2017, p. 4).

As described above, lynx distribution in this unit may have contracted with the recent apparent disappearance of resident lynx from the Garnet Mountains in the southern part of the unit. This area is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016, *pers. comm*.). As described in section 2.3.2.2 and above, whether the recent absence of lynx from this part of the unit represents the extirpation of a small but previously persistent population (and, therefore, a permanent contraction of lynx distribution in this unit) or the temporary “winking off” of a peripheral subpopulation that may become “winked on” again in the future is unknown. On February 2, 2016, a single lynx was detected via snow-track survey and verified via DNA analysis in the Garnet Range in the area previously occupied by resident lynx, demonstrating that natural recolonization of this area by dispersing lynx is possible. However, this recent record appears to have been of a dispersing/transient individual because subsequent surveys have not revealed additional detections of that lynx or any other lynx in the area, and there currently remains no evidence of lynx residency in this mountain range (Lieberg 2017, *pers. comm.*).

Snow-tracking, hair-snare, and camera-trap surveys in other parts of this unit since the DPS was listed continued to detect lynx on the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo National Forests (USFS 2015a, pp. 9-27). On the Flathead, the RMRS trapped and radio-marked 7 lynx (3 females, 4 males) in the Flathead River watershed from 2010-2015, and surveys detected lynx in several other areas including the Salish Mountains, the

area just south of Glacier National Park, and in the vicinity of Hungry Horse Reservoir (USFS 2015a, pp. 10-11). The Swan Lake District in the southern part of the Flathead, along with the Seeley Lake District of the Lolo National Forest and the Lincoln District of the Helena National Forest, is part of the 6,070-km^2 (2,344-mi^2) Southwestern Crown of the Continent, which was intensively surveyed from 2012-2014 by the Southwestern Crown Carnivore Monitoring Team (SCCMT 2014, entire). The SCCMT conducted snow track surveys and used hair snares, bait stations, and camera traps to detect lynx in 36 of the 82, 8 x 8 km (5 x 5 mi) grid cells they surveyed (SCCMT 2014, pp. 3, 17-20). The surveys resulted in collection of DNA that allowed identification of 18 individual lynx (5 females, 13 males), 13 of which were new to regional lynx databases (SCCMT 2014, pp. 3, 17-20), indicating recruitment of new individuals into this population, or immigration, or a combination of the 2.

On the Helena National Forest, few lynx have been detected outside the Lincoln District/ Southwestern Crown area described above. In the south MacDonald Pass area, just south of this SSA unit and south of designated critical habitat, an individual male lynx was verified by DNA evidence over 4 winters (2007-2011), and an individual female was verified in the same area in the winter of 2008-2009 (Gehman *et al.* 2011, p. 21; USFS 2015a, p. 27). Other surveys on the Helena National Forest failed to detect lynx in the disjunct Big Belt and Elkhorn Mountains, although telemetry data indicated that 3 lynx released in Colorado passed through the Big Belts in 2004-2006 (USFS 2015a, pp. 26-27). Likewise, during snow tracking surveys on the Lolo National Forest in 2010-2011 (prior to the Southwestern Crown monitoring described above), lynx were also confirmed on the Seeley Lake District in the eastern part of the forest, but no lynx were documented on the Missoula or Ninemile districts, nor on the Superior and Plains/Thompson Falls districts in the western part of the forest (USFS 2015a, pp. 12-14). The USFS concluded that lynx presence in districts other than Seeley Lake is extremely rare and likely represents occasional dispersing lynx (USFS 2015a, p. 21).

On the Kootenai National Forest, RMRS research trapping and telemetry efforts continued to document the long-term presence of lynx from 2003-2012 (USFS 2015a, p. 10). On the Lewis and Clark National Forest, lynx are considered “still present” in the Rocky Mountain Front portion of the forest, which is within this geographic unit and designated critical habitat, and snow track surveys from 2010-2013 in the disjunct Little Belt and Crazy Mountains documented the continued absence of resident lynx in those ranges (USFS 2015a, pp. 25, 27-34). In Idaho, surveys in 2006-2007 by the Coeur d’Alene Tribe recorded 1 lynx detection in the Coeur d’Alene Mountains and 1 in the Saint Joe Mountains (Albrecht and Heusser 2009, entire). On the Idaho Panhandle National Forest, Multi-species Baseline Initiative (MBI) surveys in 2010-2014 detected 5 individual lynx (2 males, 3 females): 1 male in the Selkirk Mountains; 1 male and 2 females in the Purcell Mountains (and another 18 detections not identifiable to individual), and 1 female in the West Cabinet Mountains (Lucid *et al*. 2016, pp. 158-160). All detections were within 50 km (31 mi) of the Canada border, 3 detections were of incidentally-trapped lynx (2 in the West Cabinets released unharmed [1 with a radio collar] and 1 in the Purcells that died), and no lynx were detected in the Coeur d’Alene or Saint Joe Mountains (Lucid *et al*. 2016, p. 180). MBI follow-up surveys in 2015-2016 targeting areas where lynx were detected in 2010-2014 resulted in 89 lynx detections representing a minimum of 6 individual lynx; 1 in the Selkirks, 4 in

the Purcells (including camera images of an adult traveling with 2 young and later on the same camera an adult traveling with 1 juvenile), and 1 in the West Cabinets (IDFG 2017a, p. 5). No lynx were detected in the Saint Joe Mountains.

In summary, although the number of lynx in this geographic unit is uncertain, resident lynx appear to remain broadly distributed throughout much of the unit as evidenced by continued documentation of lynx in the research surveys described above. Genetic analyses and snow and camera surveys have verified continued reproduction and recruitment among lynx populations in this unit and also suggest some immigration may be occurring. The recent apparent absence of resident lynx in Garnet Mountains may indicate extirpation of a small resident population and a contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure. Lynx are rarely detected on surveys on other national forests (or parts of those above) that are outside but adjacent to this geographic unit (Patton 2006, entire; USFS 2105a, pp. 1-9, 25-34), suggesting that these areas lack the habitat features and/or landscape-level hare densities necessary to support resident lynx populations (79 FR 54818-54820).

Factors Affecting Current Conditions

Regulatory Mechanisms - Federal management activities (especially timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current Federal regulatory mechanisms likely impacted some lynx habitats by altering the distribution and quality of hare habitats. However, because these activities occurred in low proportions of lynx habitat on Federal lands and impacts appear to have been localized, they were deemed a low-level threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past Federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. For example, as described above in *Habitat Status* and *Lynx Status*, past timber harvest/management and associated road construction may have fragmented, reduced the amount, and altered the distribution of lynx habitats in the Garnet Mountains, perhaps contributing to the apparent recent loss of that area’s ability to support resident lynx.

Currently, as described above and in section 3.1, all Federal and Tribal lands, most State lands, and large blocks of private or formerly-private land in this unit are managed for the conservation of lynx habitats, and much of the unit is in designated wilderness or other nondevelopmental land-use allocations. Regulatory mechanisms and conservation measures associated with these management strategies are intended to conserve and restore lynx and hare habitats across large landscapes and multiple ownerships. Although their effectiveness has not been quantitatively evaluated, and despite the potential extirpation of a small population in the Garnets, lynx habitats and resident lynx appear to remain well distributed throughout most of this unit.

Other regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, 16 lynx are documented to have been incidentally trapped in Montana, with 13 of those occurring before 2008, when more protective regulations (e.g., lethal snares prohibited for bobcat sets, leaning pole sets limited to < 4" pole that must be 48" above ground for marten, fisher, and wolverine) were put in place (MTFWP 2016, pp. 5-10). Of the 16, 8 were released uninjured, 1 was released with an injury, and 7 were killed; all incidences of mortality occurred prior to 2008 and prior to the implementation of the more protective regulations (MTFWP 2016, p. 5). In Idaho, in addition to the 3 lynx incidentally trapped on the Idaho Panhandle National Forest from 2012-2014 (described above under *Lynx Status*), 1 other lynx was incidentally trapped in 2012 on the Salmon-Challis National Forest further south.

Although lynx are legally trapped in Canada adjacent to this unit in southern Alberta and southern British Columbia, trapping there is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Environment Canada 2014, entire; Vashon 2015, pp. 5-6). Lynx harvest in Alberta varied from about 4,000 to 14,000 annually in the late 1970s and early 1980s, but declined to fewer than 2,000 for most years from 1984-2000, and restrictive quotas and season closures were implemented beginning in the late 1980s (Poole and Mowat 2001, pp. 16, 28). Similarly, harvests in British Columbia peaked at over 12,000 in the early 1960s and over 8,000 in the early 1970s, then declined to fewer than 2,000 for most years from the mid-1980s until the year 2000 (Hatler and Beal 2003, p. 2). Whether (and if so to what extent) trapping in Canada may influence lynx dispersal across the border and into this geographic unit is unknown; however, such dispersal was documented historically when harvest levels in Canada were much higher than under current management.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Hall and Fagre 2003, entire; Mote 2003b, entire; Fagre 2005, entire; Knowles *et al.* 2006, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016a, pp. 14-15; Squires *in* Lynx SSA 2016, p. 20; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016a, pp. 15-16; Siren *in* Lynx SSA Team 2016a, p. 15; see also sections 3.2, and 5.2.3). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the unit's current ability to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, lynx habitats in this unit are naturally highly-fragmented and hare densities, even in areas considered high-quality habitat for this DSP unit, often appear to barely meet the 0.5 hares/ha (0.2 hares/ac) threshold thought necessary to support resident lynx.

Therefore, even relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 90-95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.2.3). As described in section 3.2, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609). Although insect outbreaks have affected some parts of the DPS, no major outbreaks have been documented in lynx habitats in this unit (Lynx SSA Team 2016a, p. 41).

Vegetation Management - As elsewhere in the DPS range, timber harvest and related vegetation management (precommercial thinning and other silvicultural techniques designed to optimize forest products outputs; ILBT 2013, pp. 71-72) are the dominant land uses potentially affecting lynx habitats in this unit (68 FR 40075, 40092; 79 FR 54825). As described in section 3.3, these activities can reduce hare and lynx habitats by reducing horizontal cover and altering natural disturbance regimes and forest successional patterns. In this unit, precommercial thinning was shown to reduce short-term hare abundance (Griffin and Mills 2007, entire) and appeared to influence lynx movements (Squires *et al.* 2013, p. 192-194), and lynx rarely traveled across recent clearcuts or other large openings, especially in winter (Squires *et al.* 2010, p. 1654; ILBT 2013, p. 77). However, as described under *Habitat Status*, above, these activities on Federal lands, which account for most of the lands in this unit, occur only on lands with developmental allocations and historically appear to have impacted only a small proportion of potential lynx habitats in this unit (65 FR 16072; 68 FR 40093). Additionally, timber harvest levels on Federal lands in the West, including the Northern Rockies, and specifically with regard to “lynx forest types,” had declined consistently and dramatically for a decade or longer prior to the DPS being listed (68 FR 40093), and have remained at levels much lower than those from most of the previous century. Despite some likely localized impacts, past vegetation management does not appear to have broadly diminished this unit's ability to support resident lynx, although, as described above, it may have contributed to the current absence of a small number of resident lynx from the Garnet Mountains. Also as described above, current vegetation management in this unit on all Federal, most State and Tribal, and some private lands, is conducted in accordance with formally amended USFS and BLM management plans, an approved State HCP, Tribal regulations, and conservation easements designed to avoid or minimize impacts to lynx habitats, especially important hare and lynx winter foraging habitats.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008a, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, where

about 15 percent (4,172 km^2 [1,611 mi^2]) of the forest area in this unit burned from 2000-2013 (Squires *in* Lynx SSA Team 2016a, p. 20), likely in response to climate warming and related increases in drought conditions (e.g., Harvey *et al.* 2016, entire; Westerling 2016, entire). During the 2017 fire season alone, roughly 1,150 km^2 (444 mi^2; over 4 percent of the unit) burned, including the Rice Ridge and Reef fires, which together burned over 690 km^2 (267 mi^2) in the core of the Seeley Lake population's habitat and the site of long-term lynx research by the RMRS.[19] Although these fires likely have reduced or will reduce lynx carrying capacity in some parts of this geographic unit, we expect such impacts to be temporary, with burned areas regenerating into high-quality lynx and hare habitats 20-40 years post-fire. Thus far, we are aware of no evidence that increased fire activity has permanently reduced lynx populations or diminished this geographic unit's ability to support resident lynx. However, with climate-driven elevated wildfire activity projected to continue into the future, such impacts are possible, depending on the location, timing, and extent of future fires (see section 5.2.3, below).

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction. In the Northern Rocky Mountains, the forests upon which lynx depend have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx (with the possible exception of the Garnet Mountains). Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Idaho (1; USFWS 2016c; MTFWP *unpubl. data*). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2). However, whether, and if so to what the extent, the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. This unit is directly connected to lynx habitats and populations in southwestern Alberta and southeastern British Columbia, where lynx habitats are also (like Montana and Idaho) patchily-distributed and generally support low hare densities, and where some lynx populations may be ephemeral and the persistence of others reliant on periodic immigration (Apps 2007, pp. 81, 95-104). Additionally, connectivity between this geographic unit and lynx habitats and populations in southern Alberta and southern British Columbia may be facilitated by only a few predicted corridors that extend south from the international border (Squires *et al.* 2013, pp. 187, 191-193).

[19] https://inciweb.nwcg.gov/state/27/0/

Although lynx occurrence and harvest records in this geographic unit reflect the unprecedented irruptions of lynx from Canada into the northern contiguous United States in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 224-226, 232-242), there is no evidence of irruptions of lynx into this unit after the 1980s (Squires *in* Lynx SSA Team 2016a, p. 20). This is supported by lynx trapping records from Canada, which suggest that the magnitude of lynx population cycles in Alberta and British Columbia dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Poole and Mowat 2001, p. 28; Hatler and Beal 2003, p. 2; Bowman *in* Lynx SSA Team 2016a, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5[20]).

A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2), which would be expected to alter the timing and magnitude of irruptions of lynx from Canada into the contiguous United States. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and a reduced likelihood of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area (λ = 0.92, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016a, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. In contrast, the growth rate estimated for the lynx population in the Purcell Mountains in the northwestern part of this unit (λ = 1.16, increasing trend 2003-2007; Squires *in* Lynx SSA Team 2016a, p. 20) suggests that the level of immigration, if necessary for demographic stability, has been adequate or that productivity and recruitment have been high enough to offset potentially diminished immigration. It is also possible that, despite the documented historical intermittent (cyclic) influxes of lynx from Canada into lynx populations in this geographic unit, immigration does not contribute meaningfully to the demographic stability of these populations. If that is the case, the estimated growth rates suggest that recruitment has failed to offset mortality in the Seeley Lake population but that it has more than done so in the Purcell Mountains population. However, Schwartz (2017, p. 4) noted that very low immigration rates (less than 1 female/year on average for a theoretical population of 100 lynx) could provide population stability or even growth, suggesting that the Seeley Lake population and perhaps other DPS populations are probably being sustained by low levels of undetected immigration. The growth rate estimates presented above assumed no immigration.

4.2.4 Unit 4 - North-central Washington

Unit Description: This geographic unit is located on the eastern side of the northern Cascade Mountain Range of north-central Washington in portions of Chelan and Okanogan Counties. It includes mostly Okanogan-Wenatchee National Forest lands as well as BLM lands in the Spokane District that were designated as critical habitat for lynx in 2014 (79 FR 54825). The unit also includes State Forest lands (portion of the Loomis State Forest) that were excluded from

[20] https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf.

designation as critical habitat (79 FR 54825). It encompasses approximately 5,176 km^2 (1,988 mi^2), with ownership that is 91.5 percent Federal (USFS, BLM), 8.2 percent State, and 0.3 percent private lands; there are no Tribal lands in this unit. This unit is about 200 km (125 mi) west of the Northern Montana/Northeastern Idaho geographic unit. This area was occupied by resident lynx when the DPS was listed and remains occupied currently. Evidence from recent research and DNA analysis shows lynx distributed within this unit, and breeding has been documented. Although researchers have fewer records in the portion of the unit south of Highway 20, this area contains boreal forest habitat and is thought to support resident lynx. Further, it is contiguous with lynx habitat north of Highway 20, particularly in winter when deep snows close Highway 20. The northern portion of the unit adjacent to the Canada border also appears to support few recent lynx records; however, it is designated wilderness and access to survey this area is difficult. This northern portion contains extensive boreal forest vegetation types and also likely supports resident lynx. Additionally, lynx populations exist in British Columbia directly north of this unit.

This geographic unit represents 58 percent of the 8,923-km^2 (3,445-mi^2) Okanogan Lynx Management Zone (LMZ) identified by the WADFW (Stinson 2001, p. 16). Five smaller and relatively disjunct LMZs to the east of this geographic unit (Vulcan-Tunk, Kettle Range, The Wedge, Little Pend Oreille, and Salmo Priest) combined represent another 3,656 km^2 (1,412 mi^2) of potential lynx habitat known or thought to have historically and perhaps recently supported a small number of lynx, at least intermittently. Among these, the Kettle Range LMZ was thought to support a small (likely fewer than 20 individuals) resident lynx population as recently as the late 1970s that may have been extirpated as a result of overharvest compounded by habitat changes (Stinson 2001, pp. 14-16; Koehler *et al.* 2008, p.1523; see Lynx Status, below).

Habitat Description: In the northern Cascades most lynx occurrences are associated with the Rocky Mountain Conifer Forest (Aubry *et al.* 2000, p. 379; McKelvey *et al.* 2000a, p. 246) at elevations between 1,400 m (4,593 ft) and 2,150 m (7,053 ft; McKelvey *et al.* 2000d, p. 322; Stinson 2001, p. 9). Within this area lynx primarily use forests dominated by Engelmann spruce, subalpine fir, or lodgepole pine on mild to moderate slopes (< 30°), and avoid Douglas-fir and ponderosa pine forests, forest openings, recently burned areas with sparse canopy and understory cover (< 10 percent), low elevations [less than 915 m (3,000 ft)], and steep slopes (> 30°; Koehler *et al.* 2008, pp. 1518, 1521; Maletzke 2004, pp. 16-17). Similar to the Northern Rocky Mountains, lynx habitat in the North Cascades is naturally fragmented (Koehler *et al.* 2008, p. 1523). As in other boreal forest systrems, fires and insect outbreaks are major drivers of disturbance in this unit, but other factors, including wind and tree diseases, also contribute to natural disturbance regimes (Agee 2000, p. 47). Fire return intervals in the North Cascades range between approximately 100 to 250 years (Agee 2000, p. 50). Average annual snowfall is consistent throughout this unit and is approximately 291 cm (115 in)[21].

Walker (2005, p. 20) estimated an average snowshoe hare density of 0.89 hares/ha (0.36 hares/ac) with a range of 0.03 to 4.85 hares/ha (0.01 to 1.94 hares/ac) in the North Cascades.

[21] https://snowfall.weatherdb.com/d/a/Washington; accessed 4.27.2016.

The WADNR estimated snowshoe hare densities between 0.3 and 0.7 hares/ha (0.1 and 0.3 hares/ac) on the Loomis State Forest (WADNR 2006, p. 87). Koehler (1990a, p. 848) found snowshoe hares were the primary prey of lynx in the North Cascades, occurring in 23 of 29 (79 percent) lynx scats examined. The remains of red squirrels were identified in 24 percent of scats, which also included remains of other species including deer and mice. Similarly, Von Kienast (2003, p. 39) found snowshoe hares in 87 percent (40 of 46) of lynx scats in the North Cascades, while red squirrels were identified in 28 percent of scats.

Habitat Status: Lynx habitat in this geographic unit has been reduced and fragmented by multiple large wildifres over the past several decades that have likely caused a reduction, perhaps temporary, in the number of resident lynx in the unit (Lewis 2016, pp. 4-6; Lyons *et al*. 2016, entire; Maletzke *in* Lynx SSA Team 2016a, p. 21; see Lynx Status below). Several wildfires affected lynx habitat in the North Cascades during the middle 1990s and early 2000s: 1994 Whiteface Burn (15.5 km^2 [6 mi^2]); 1994 Thunder Mountain Fire (36.9 km^2 [14.2 mi^2]); 2001 Thirty-Mile Fire (25.7 km^2 [9.9 mi^2]); and 2001 Farewell Fire (323 km^2 [125 mi^2]; Vanbianchi 2015, p. 23). Subsequent to those fires and incorporating research on lynx habitat use, Koehler *et al.* (2008, p. 1522) estimated that the Okanogan LMZ (including this geographic unit) contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat, and that the other 5 LMZs in the northeastern corner of the state, combined, contained an additional 1,381 km^2 (533 mi^2) of suitable habitat. More recent wildfires, including the 2006 Tripod Fire (706 km^2 [273 mi^2]; Vanbianchi 2015, p. 23), have affected approximately 1,000 km^2 (386 mi^2) of lynx habitat in the Okanogan LMZ (Maletzke *in* Lynx SSA Team 2016a, p. 21), and the Diamond Creek fire burned another 393 km^2 (152 mi^2) in the northern part of this unit during July-October 2017, along with another 126 km^2 (49 mi^2) across the border in southern British Columbia[22].

Recently, Lewis (2016, pp. 4-6, fig. 3, table 2) estimated that about a third (3,130 km^2 [1,209 mi^2]) of the total forested area in the Okanogan LMZ burned from 1992 to 2015, and that the amount of suitable lynx habitat in the LMZ similarly declined by 37 percent, from 2,581 km^2 (997 mi^2) in 1996 to 1,630 km^2 (629 mi^2) in 2014. In the Kettle Range, Lyons *et al*. (2016, p. 5) estimated that about 11 percent (360 km^2 [139 mi^2]) of the LMZ burned from 2000 to 2015, and Lewis (2016, p. 6) estimated that the amount of suitable lynx habitat in the LMZ declined by about 7 percent, from 404 km^2 (156 mi^2) in 1996 to 376 km^2 (145 mi^2) in 2014. Cumulatively, Lewis (2016, p. 6) estimated that suitable lynx habitat in north-central and northeastern LMZs in Washington declined by 26 percent, from 3,770 km^2 (1,456 mi^2) in 1996 to 2,790 km^2 (1,077 mi^2) in 2014, with 97 percent of the losses occurring in the Okanogan LMZ and attributable to large wildfires over the past 25 years. This estimate does not include impacts of the 2017 Diamond Creek wildfire described above. These burned areas are expected to regenerate back into suitable lynx habitat, but it may take 10 to 40 years for that to occur (Lewis 2016, p. 5; Maletzke *in* Lynx SSA Team 2016a, p. 21), during which time the resident lynx population in this geographic unit will likely be at increased risk of stochastic demographic, genetic, and environmental effects.

[22] https://inciweb.nwcg.gov/incident/5409/, accessed 10/25/2017.

As it is throughout the DPS range, maintaining connectivity with Canada is believed to be important to the conservation of resident lynx in this geographic unit (ILBT 2013, p. 65). Singleton *et al.* (2002, p. 46) reported broad landscape permeability for lynx between the northern Cascades and the Thompson River watershed in British Columbia. With no known barriers and lynx dispersal from this unit into Canada recently documented, connectivity with lynx populations and habitats in Canada currently appears functional (ILBT 2013, p. 65). Outside of this geographic unit, lynx habitat in the Kettle Range and the other northeastern LMZs is limited in size and potentially capable of supporting only a few lynx. Koehler *et al.* (2008, p. 1523) estimated the Kettle Range could support 10 to 23 lynx based upon a lynx density of 2.3 lynx/100km^2 and 400 km^2 (154 mi^2) to 987 km^2 (381 mi^2) of lynx habitat. However, that lynx density estimate was derived from research conducted in the Cascade Range within a large area of contiguous, high-quality habitat (Koehler 1990a, pp. 845, 847). Lynx habitat in the Kettle Range is much smaller and likely more fragmented, and may not be capable of supporting a similar density. The Kettle Range is also somewhat isolated from other lynx habitats in Washington and British Columbia. The Kettle Range is separated from the Cascades in Washington by low elevation valleys dominated by shrub-steppe and Douglas-fir and ponderosa pine forests (Koehler *et al.* 2008, p. 1523), and from British Columbia by the Kettle River Valley (Stinson 2001, p. 20) and a major highway corridor with associated wildlife fencing in British Columbia (Koehler *et al.* 2008, p. 1523). These natural topographic and anthropogenic features may impede lynx movement between the Kettle Range and the Cascades and British Columbia, perhaps reducing the likelihood of natural recolonization and re-establishment of a resident breeding population in the Kettle Range.

Lynx Status: In Washington, there is little information on the status of lynx prior to the early 1960s (Stinson 2001, p. 13) because lynx trapping records were not maintained in Washington prior to 1961. From 1960 to 1991 a total of 234 lynx was harvested in Washington, with the most (35 percent) lynx trapped in Ferry County, followed by Okanogan (23 percent) and Stevens (10 percent) counties (Stinson 2001, p. 13). Lynx were trapped relatively consistently in the Kettle Range in the 1960s, 1970s, and 1980s, with a total of 81 lynx harvested from 1961 through 1986 (Stinson 2001, p. 63). Beginning in 1978, trapping seasons for lynx in Washington were reduced to 1 month. In 1987 a restricted permit system was implemented, and in 1990 a statewide closure on lynx trapping was implemented (USFWS 2008a, p. 2). In 1993, lynx were classified by the Washington Fish and Wildlife Commission as a State threatened species (Stinson 2001, p. 22). In 2001, the WADFW considered lynx to be present in the Okanogan, Kettle Range, Little Pend Oreille, and Salmon-Priest LMZs; at that time lynx had not been detected in the Wedge LMZ since 1987 nor the Vulcan-Tunk LMZ since 1990 (Stinson 2001, p.15). In its October, 2016, *Periodic Status Review for the Lynx*, the WADFW recommended that the Washington Fish and Wildlife Commission uplist the lynx from a State threatened to a State endangered species because of: 1) observed range contraction in Washington following protection efforts; 2) the substantial loss of habitat in the last 20 years; and 3) the ongoing and anticipated threats to lynx population persistence (Lewis 2016, pp. iii; WADFW 2016, entire). In December, 2016, the Commission approved WADFW's review and adopted its recommendation to uplist lynx to endangered (WAFWC 2016, p. 3).

As elsewhere in the DPS, there are no reliable historical or current estimates of the number of resident lynx in this geographic unit. In 2001, based on data collected from lynx telemetry studies conducted in the Cascade Range during the 1980's, the WADFW estimated that Washington contained approximately 12,579 km^2 (4,857 mi^2) of potential lynx habitat which it felt could theoretically support up to 238 lynx, including up to 149 lynx in the Okanogan LMZ (based on a lynx density of 2.5 lynx/100 km^2; Stinson 2001, p. 16). However, based on professional opinions of individuals knowledgeable about lynx and lynx habitat and on surveys conducted as of 2000, the WADFW concluded that the State's lynx population almost certainly numbered fewer than 200 and perhaps fewer than 100 lynx at that time (Stinson 2001, p. 16). Koehler *et al.* (2008, p. 1523) later estimated there was approximately 3,800 km^2 (1,467 mi^2) of suitable lynx habitat in Washington's 6 LMZs, potentially capable of supporting up to 87 resident lynx. This revised estimate of potential carrying capacity was based on a study investigating lynx habitat use in the Okanogan from 2002 to 2004, and used a lynx density estimate of 2.3 lynx/100 km^2 derived from a radio-telemetry study of lynx in the Cascades from 1985-1987 (Koehler 1990a, pp. 845-847). However, the study area from which the 2.3 lynx/100 km^2 density estimate reported by Koehler (1990a, p.847) was derived is located in an area of the northern Cascades known as the "Meadows". During the time of Koehler's study, the Meadows provided some of the best lynx habitat in Washington, whereas most other potential lynx habitat in Washington is lower in elevation and more highly fragmented (Walker 2005, pp. 3, 6). Thus, the lynx densities Koehler observed in his study area in the Meadows may not be applicable to other areas of potential lynx habitat in Washington, because as habitat becomes more fragmented and isolated, the carrying capacity for lynx likely declines. Therefore, applying Koehler's estimated density uniformly throughout Washington would likely overestimate the number of resident lynx potentially supported in Washington.

More recently, Lewis (2016, pp. 5-6) estimated that wildfires over the last several decades (see Habitat Status section above) have reduced the carrying capacity of the Okanogan LMZ by 37 percent, from 43 females (86 total lynx assuming similar numbers of males and females) in 1996 to 27 females (54 total lynx) in 2014. The author estimated a minor decline in carrying capacity in the Kettle Range LMZ from 8 females (16 total lynx) in 1996 to 7 females (14 total lynx) in 2014. Overall, Lewis (2016, p. 6) estimated that suitable lynx habitat in north-central and northeastern LMZs in Washington declined by 26 percent from 1996 to 2014, with most of the losses resulting from large wildfires in the Okanogan LMZ, and that lynx carrying capacity in the State declined by 29 percent from 58 females (116 total lynx) to 41 females (82 total lynx) over that time period. However, considering a dramatic increase in female home range size (from about 39 km^2 [15 mi^2] during 1990-2002 to 91 km^2 [35 mi^2] by 2014), likely a result of fire-driven habitat loss and fragmentation, Maletzke (*in* Lynx SSA Team 2016a, p. 21) suggested that the carrying capacity of the Okanogan LMZ alone, which encompasses this geographic unit, may have declined from 90-115 females (180-230 total resident lynx) to as few as 27 females (54 total resident lynx) currently. Maletzke's estimate suggests a much larger (70 to 77 percent) potential decline in carrying capacity in this LMZ and, therefore, in the North-central Washington geographic unit. Because of these habitat impacts, limited demographic information, and remaining uncertainties (e.g., immigration/emigration rates, changes in snowpack, disease, lynx population status and impacts of trapping in southern British Columbia, and habitat corridor

stability between British Columbia and this unit; WADFW 2017, p. 3),the Washington Department of Fish and Wildlife recently submitted, and the State Fish and Wildlife Commission adopted, a proposal to uplist lynx from threatened to endangered within the State.

From 1985 to 1987, Koehler (1990a, entire) monitored the movements of 5 adult male and 2 adult female radio-collared lynx in the Cascades of north-central Washington. Results of the study indicated average female home range size was 39 km^2 (15 mi^2) and average male home range size was 69 km^2 (27 mi^2). Based on occupancy of the 640 km^2 study area by 15 adult lynx, adult lynx density was estimated to be 2.3 adults/100 km^2. Annual adult survival rates of the radio-collared lynx were 0.73 in 1986 and 1.00 in 1987, and kitten mortality was high at 88 percent with only 1 of 8 known kittens surviving its first year (Koehler 1990a, p. 847).

Factors Affecting Current Condition

Within Washington, the vast majority of lynx habitat is administered by the Okanogan-Wenatchee (OWNF) and Colville (CNF) National Forests. The North Cascades (i.e., the Okanogan LMZ in north-central Washington), which supports the only known, long-term persistent lynx breeding population in Washington, and within which critical habitat was designated for lynx in 2014 (79 FR 54782), is administered by the OWNF. Subsequent to listing lynx under the ESA, the Forest Service entered into a Conservation Agreement (CA) with the Service in 2000 (USFS and USFWS 2000, entire), which was revised and extended in 2006 (USFS and USFWS 2006, entire). The CA committed the OWNF and CNF to use the Lynx Conservation Assessment and Strategy (LCAS) for management of lynx and its habitat on their ownerships, and will remain in place until the forests amend or revise their individual LRMPs.

In Washington, and the north Cascades specifically, it appears that the single threat for which lynx were listed under the ESA (i.e., inadequacy of Federal regulatory mechanisms) has largely been addressed through the development of the LCAS, and CA between the USFS and Service, which commits the USFS, specifically for Washington the OWNF and CNF, to use the LCAS in the management of lynx habitat on National Forest System lands and when designing and implementing projects within LAUs.

The WADNR manages approximately 4 percent of the lynx habitat within portions of each of the delineated LMZs (WADNR 2006, p.9) in Washington State, including the Loomis State Forest that is located in the north Cascades within the Okanogan LMZ. In 1996, the WADNR developed and implemented a Lynx Habitat Management Plan (1996 Lynx Plan) in response to listing of the lynx as a State threatened species by Washington State (WADNR 1996, entire). After the DPS was Federally listed as threatened, the WADNR in 2006 modified its Lynx Habitat Management Plan to incorporate new science and management standards and guidelines to avoid the incidental take of lynx in accordance with the ESA (WADNR 2006, entire). These standards and guidelines address maintenance of lynx denning and foraging habitat, as well as habitat connectivity within and between LAUs and lynx populations within Washington (i.e., LMZs) and Canada.

For example, the WADNR 2006 Lynx Plan includes, among other things: (1) Encouraging genetic integrity at the species level by preventing bottlenecks between British Columbia and Washington by limiting size and shape of temporary non-habitat along the border and maintaining major routes of dispersal between British Columbia and Washington; (2) Maintaining connectivity between subpopulations by maintaining dispersal routes between and within zones and arranging timber harvest activities that result in temporary non-habitat patches among watersheds so that connectivity is maintained within each zone; (3) Maintaining the integrity of requisite habitat types within individual home ranges by maintaining connectivity between and integrity within home ranges used by individuals and/or family groups; and (4) Providing a diversity of successional stages within each LAU and connecting denning sites and foraging sites with forested cover without isolating them with open areas by prolonging the persistence of snowshoe hare habitat and retaining coarse woody debris for denning sites. The 2006 Lynx Plan also describes how WADNR will monitor and evaluate the implementation and effectiveness of the plan. The WADNR has been managing for lynx for almost 2 decades, and the Service has concluded that the management strategies implemented are effective. In the 2014 final revised critical habitat designation, we determined that the benefits of excluding lands managed in accordance with the WADNR 2006 Lynx Plan outweighed the benefits of including them in the designation, and that doing so would not result in extinction of the species (extirpation of the DPS; 79 FR 54834–54835).

In summary, recent wildfires have, perhaps temporarily, eliminated or reduced the quality of over 40 percent of the higher-quality lynx habitat within the North Cascades (Lewis 2016, pp 4-6; Maletzke *in* Lynx SSA Team 2016a, p. 21), which has reduced lynx carrying capacity and significantly affected the status of and current viability of the lynx population within this geographic unit. This geographic unit likely supports fewer resident lynx currently than it did historically, making the current, smaller population more vulnerable to environmental, demographic, and genetic stochasticity and to large catastrophic events (Lewis 2016, p. 5). Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943), and as discussed in chapter 5, climate change may similarly affect the future viability of lynx within this geographic unit.

4.2.5 Unit 5 - Greater Yellowstone Area

Unit Description: This geographic unit includes the parts of southwestern Montana and northwestern Wyoming the Service designated as critical habitat (Unit 5) for lynx in 2014 (79 FR 54825-54826). It encompasses approximately 23,691 km^2 (9,147 mi^2) in portions of Carbon, Gallatin, Park, Stillwater, and Sweetgrass Counties in Montana; and Fremont, Lincoln, Park, Sublette, and Teton Counties in Wyoming, with ownership that is 97.5 percent Federal (USFS, NPS, and BLM); 2.2 percent private; and 0.3 percent State. This unit includes parts of Grand Teton and Yellowstone national parks and the Bridger-Teton, Custer-Gallatin, and Shoshone National Forests, and lands managed by the BLM's Kemmerer and Pinedale Districts. It includes parts of the Absaroka, Beartooth, Gallatin, Gros Ventre, Salt River, Teton, Wind River, and Wyoming mountain ranges. This unit is not directly connected to lynx habitats and

populations in Canada or to other DPS populations, although lynx dispersing from the north likely arrived intermittently into the area historically and, more recently, some lynx released into Colorado traveled into and through this unit (Devineau *et al.* 2010, p. 526; Ivan 2017, entire; details below). Relative to other DPS lynx populations, this unit is about 145 km (90 mi) southeast of the Northwestern Montana/Northeastern Idaho unit, and roughly 400 km (250 mi) northwest of the Western Colorado geographic unit.

Habitat Description: In northwestern Wyoming and the GYA, lynx are generally associated with Engelmann spruce-subalpine fir and lodgepole pine of the Rocky Mountain Conifer Forest vegetation class, as described above (Section 4.2.3) for northwestern Montana, although these habitats, and thus lynx, typically occur at higher elevations (2,000-3,000 m [6,550-9,850 ft]) in the GYA (McKelvey *et al.* 2000a, p. 245; ILBT 2013, p. 60). Potential lynx habitat in much of the GYA is naturally marginal (patchier and composed in many places of drier forest types), with fewer shrubs and a more open understory, and generally very low to marginal hare densities, resulting in a spatially-limited distribution of lynx with large home ranges (Squires *et al.* 2003, pp. 5, 12-13; 68 FR 40090; 71 FR 66010, 66029; 74 FR 8624, 8643–8644; Hodges *et al.* 2009, entire; Berg and Gese 2010, p. 1750; 79 FR 54796; Lynx SSA Team 2016a, p. 45). Among the 3 national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 42 percent of the total national forest area (both inside and outside this unit; USFWS 2007, pp. 32, 95, 122-123).

In Yellowstone National Park, 7,732 km^2 (2,985 mi^2; about 86 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 2,784 km^2 (1,075 mi^2; 31 percent of the park, 36 percent of lynx forest types) is estimated to be potential lynx habitat (68 FR 40086). However, hares were completely absent from more than 36 percent of surveyed stands in Yellowstone National Park, and 96 percent had estimated hare densities below the 0.5 hare/ha threshold thought necessary to support resident lynx (Hodges *et al.* 2009, pp. 870, 873-877). In contrast, estimated hare densities were ≥ 0.48 hares/ha (0.19 hares/ac) in all surveyed stands on the Bridger-Teton National Forest in the southern portion of the GYA, with highest densities (1.7 hares/ha [0.69 hares/ac]) in 30-70-year-old regenerating lodgepole pine stands with dense horizontal cover, and densities of 1.2-1.6 hares/ha (0.49-0.65 hares/ac) in mature multi-story spruce-fir and mixed spruce-fir (containing aspen or lodgepole pine) stands (Berg *et al.* 2012, p. 1483). In the central Wyoming Range in the southern part of this unit, hare tracks were more abundant in seral aspen stands with a significant spruce-subalpine fir component than in aspen stands with little or no spruce-fir, and hares appeared to be absent from pure aspen stands except where they bordered spruce-fir areas (Endeavor Wildlife Research 2009, p. 4). The only lynx den sites described for this unit (the natal den and a subsequent maternal den of 1 female in 1998) occurred in a mature subalpine fir-lodgepole pine forest in the Wyoming Range, where coarse woody debris and high sapling density provided dense horizontal cover (Squires and Laurion 2000, pp. 346-347).

Average annual snowfall in this unit ranges from about 127 cm (50 in) in Bozeman and 556 cm (219 in) in West Yellowstone, Montana, on the northern and northwestern peripheries of the unit, respectively, to 280-310 cm (110-122 in) in Alpine, Dubois, and Jackson, WY near the central and southern peripheries, with most snow falling from November to March in each

place[23]. In potential lynx habitats on the Bridger-Teton National Forest in the southern half of this unit, deep snow persisted from late October through May (Berg *et al.* 2012, p. 1481).

Habitat Status: Potential lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 97 percent (23,109 km^2 [8,922 mi^2]) of this unit is in Federal ownership, including 18,877 km^2 (7,292 mi^2) in national forests under USFS management, 3,944 km^2 (1,523 mi^2) in national parks managed by NPS, and 271 km^2 (105 mi^2) managed by BLM. As described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2008 and 2010 revised its RMPs for the Pinedale and Kemmerer districts, respectively, to include conservation measures and BMPs for lynx based on the LCAS (BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). On lands with developmental land-use allocations, these amended forest plans and the revised BLM RMPs provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently-applied framework for conserving and restoring important hare and lynx habitats.

As elsewhere in the DPS (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27), winter foraging habitat is likely the most limiting habitat for lynx in this unit, and denning habitat is not thought to be limiting. Standards, guidelines and BMPs in the NRLMD and in revised BLM plans restrict vegetation management activities that could reduce winter snowshoe hare habitat and direct the creation or retention of coarse woody debris in areas where denning habitat may be lacking (USFS 2007, Attachment 1, pp. 2-5; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) modeled snow suitability across North America, showing that most of this geographic unit has a 95 percent probability of providing snow cover conditions consistent with historical lynx occurrence records (Gonzalez *et al.* 2007, p. 12).

This unit includes substantial areas in nondevelopmental land-use allocations, including (in addition to Yellowstone and Grand Teton national parks) the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie designated wilderness areas. Among the 3 national forests that contribute to this unit, 75 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34). Management activities in these areas are unlikely to adversely impact lynx and hare habitats. Large parts of Yellowstone National Park burned in the extensive wildfires of 1988. Although the extent to which those fires may have impacted potential lynx habitats is uncertain, some of the burned areas may soon reach a stage of regeneration capable of supporting increased densities of hares, perhaps

[23] https://snowfall.weatherdb.com/d/a/Montana; accessed 8.17.2016.

increasing the likelihood that lynx could reestablish and maintain home ranges in some parts of the park (Lynx SSA Team 2016a, p. 45). Because non-Federal lands make up less than 3 percent of lynx habitats in this unit, it is unlikely that activities on those lands have impacted lynx populations or meaningfully influenced the unit's current capacity to support resident lynx.

Overall, although naturally fragmented and patchily-distributed, potential lynx habitat in this geographic unit appears to be largely intact relative to historical conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway, railroad) development, past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

In summary, much of this geographic unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental land-use allocations, where management activities with the potential to adversely affect lynx habitat generally do not occur. Almost all lands with developmental land-use allocations in this unit are managed by the USFS to conserve and maintain lynx and hare habitats under management plans that were formally revised in 2007 in accordance with the NRLMD and based on the scientific findings and conservation recommendations of the LCAS. A small proportion of lands with developmental allocations occurs on BLM lands where management plans also were revised recently (2008 and 2010) to adopt conservation measures identified in the LCAS. Implementation of these USFS and BLM plans likely precludes landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places. Additionally, because lynx habitats in this unit are naturally highly-fragmented and, in most places, support low landscape-level hare densities, relatively minor impacts, especially to hare and lynx winter foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historical or current number of resident lynx in this unit. As described in section 2.3.2.2 above, the historical record and recent research show that the GYA has supported resident lynx at least occasionally, but it is unclear whether the area consistently supported a persistent resident population over time or whether it naturally supported resident lynx only intermittently. Most historical and recent verified lynx records are from the southern portion of this unit in the Gros Ventre, Salt River, Wind River, and Wyoming mountain ranges in the Bridger-Teton National Forest. Reeve *et al*. (1986a, entire; 1986b, entire), who compiled all lynx records state-wide in Wyoming from 1856-1986, reported 22 verified ("certain") records and over 200 unverified ("probable") records based on trapping reports and observations of animals or tracks (Reeve *et al*. 1986a, pp. 64-70. Most records were from the northwestern corner of the State (Reeve *et al*. 1986a, pp. 28-29; 1986b, pp. 6-9), which overlaps much of the GYA geographic unit. McKelvey *et al*. (2000a, pp. 229-230) reported 30 verified records for Wyoming, including those in Reeve *et al*. as well as 2 resident lynx, a male

and a female, who were trapped, radio-marked, and monitored in the Wyoming Range over several years beginning in 1996 and who produced 6 kittens over 2 years. The female had 4 kittens in 1998 and 2 in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000 (Squires and Laurion 2000, p. 346; Squires *et al.* 2001, pp. 9, 26). The female's home range averaged 50 km^2 (19 mi^2) over the 3 years she was monitored, and the male's averaged 824 km^2 (318 mi^2) over 5 years (Squires *et al.* 2003, pp. 12-13). The male also made multiple long-distance exploratory movements (up to 728 km [452 mi], including multiple highway crossings) over 3 successive years (Squires *et al.* 2003, pp. 13-16; Squires and Oakleaf 2005, entire).

As described in section 2.3.2.2, several sources reported accounts of numerous lynx being trapped in the Wyoming Range in the early 1970s. However, nearly all these records are unverified and the various anecdotal reports provide conflicting numbers and years in which lynx were purportedly trapped. These conflicting anecdotal reports illustrate compellingly why only verified records are appropriate for evaluating historical lynx distribution (McKelvey *et al.* 2000a, pp. 208-210; 2008, pp. 553-554). Even if these anecdotal records were accurate, the large numbers of lynx reported in the early 1970s correspond to the second of 2 well-documented and unprecedentedly large irruptions of lynx from Canada into the northern contiguous United States, when dispersing/transient lynx occurred temporarily in many parts of the DPS range (McKelvey *et al.* 2000a, pp. 232-242). That the sudden increase in lynx suggested by these anecdotal records would have reflected a pulse of dispersing lynx associated with that large irruption is more plausible than the notion that a previously undocumented resident lynx population suddenly and simultaneously became vulnerable to trapping in only a handful of winters.

Other surveys, however, resulted in verified detections of a small number of lynx in the southern portion of this unit from 1999-2009, with records most consistent in the Wyoming Range, Togwotee Pass, Union Pass, the Bondurant Corridor, and in the Gros Ventre Range (Squires *et al.* 2001, pp. 9-14; Squires *et al.* 2003, pp. 9-11, 29-31; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016, *pers. comm.*; Squires *in* Lynx SSA Team 2016a, pp. 20-21). At least 9 radio-marked lynx released in Colorado subsequently moved into or through the GYA unit from 1999-2010, with locations of several of these lynx concentrated in areas used previously by the native male and female described above (Devineau *et al.* 2010, p. 526; Hanvey 2016, *pers. comm.*; Ivan 2017, entire). In winter 2004-05, a male and female, both released in Colorado in spring 2004, occupied overlapping areas on the east side of the Wyoming Range (Ivan 2017, p. 3, figs. 20, 24). During the 2006 breeding season, a male and a female, both also released in Colorado in 2004, occupied overlapping areas farther north near Pinnacle Buttes along Highway 287 (Ivan 2017, p. 3, figs. 21, 23). However, there is no evidence that either of these pairs bred or that either female denned or produced kittens (Ivan 2017, p. 3). On the Shoshone National Forest in the northeastern part of this unit, analysis of DNA collected during winter surveys confirmed 7 lynx snow tracks in winter 2005/06 and a single track in 2006/07 (Endeavor Wildlife Research 2008, p. 2; Berg 2016, *pers. comm.*). Overall, during the 4 winters of 2004-05 through 2007-08, 26 snow tracks on the Bridger-Teton and Shoshone National Forests were confirmed by DNA analyses to be from 5 individual lynx (3 males, 2 females). One of the males had

previously been documented in Yellowstone National Park (see below). The other 2 males and both females were lynx that had been released in Colorado (Pilgrim 2016, *pers. comm.*).

Verified records of lynx are less common elsewhere in this unit, including in Yellowstone and Grand Teton national parks and the Custer-Gallatin National Forest. There were no verified records of lynx in Yellowstone National Park from 1920-1999 (McKelvey *et al.* 2000a, p. 230); however, surveys in 2001-2004 documented at least 3 individual lynx, including 2 kittens, in the eastern part of the park (Murphy *et al.* 2006, entire). On the Custer-Gallatin National Forest in Montana in the northern part of the unit, a single female was detected over 6 consecutive winters (2003/2004 - 2008/2009) but not subsequently (Gehman *et al.* 2010, pp. 2-4), and it appears that she did not encounter a male or produce kittens during the 6 years she was detected (Gehman *et al.* 2010, p. 4).

Recent surveys and research-related trapping efforts have failed to detect lynx in this unit after 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016a, pp. 20-21, 45; Hanvey 2016, *pers. comm.*). As discussed above and in section 2.3.2.2, it is uncertain whether this unit historically supported a small but persistent resident population that was recently extirpated, or if it historically and recently supported resident lynx only intermittently. Given the protected conservation status of millions of acres in this unit, its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx (Lynx SSA Team 2016a, p. 57). Conversely, the characteristics described above suggest that relatively small impacts could shift potential habitats in this unit from just barely able to support a persistent resident population to incapable of doing so. Further, the available evidence suggests that if this unit did support a persistent population, it was very likely a very small one, which would be more vulnerable to extirpation as a result of demographic, environmental, and genetic stochasticity, catastrophic events (McKelvey *et al.* 2000b, pp. 23-29), or a combination of these factors.

Factors Affecting Current Conditions

Regulatory Mechanisms - As described above for Unit 3, Federal management activities (e.g., timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current Federal regulatory mechanisms likely impacted some lynx by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on Federal lands and impacts appear to have been localized, they were deemed a low-level to threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past Federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. Current regulatory mechanisms and conservation measures associated with recently amended or revised Federal management plans are intended to conserve and restore lynx and hare habitats across large landscapes. Although their effectiveness has not been quantitatively evaluated, they have almost certainly reduced significantly the potential for adverse management-related impacts to lynx habitats in this unit.

Lynx trapping has been prohibited in Wyoming since 1973 (79 FR 54794) and in Montana since 1999 (MTFWP 2016, p. 7) and, as described in section 3.1.2, both states require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, no lynx are documented to have been incidentally trapped in the Montana portion of this unit (MTFWP 2016, pp. 5-10) and we are aware of no incidental captures in northwestern Wyoming since listing.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Mote *et al.* 2005, entire; Pederson *et al.* 2013, entire; Riley *et al.* 2013, entire; Dennison *et al.* 2014, entire; USEPA 2015, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016a, pp. 14-15; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016a, pp. 15-16; Siren *in* Lynx SSA Team 2016a, p. 15; see also sections 3.2, and 5.2.3). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, lynx habitats in this unit are naturally highly-fragmented and hare densities low in some places. Therefore, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.2.5). As described in section 3.2, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609).

Vegetation Management - The influence of vegetation management on the current condition of lynx and habitats in this unit is described above under Habitat Status and *Regulatory Mechanisms*, above.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008a, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, likely in response to climate warming and related increases in drought conditions (e.g., Dennison *et al.* 2014, entire; Harvey *et al.* 2016, entire; Westerling 2016, entire), with most large, stand-

replacing fires having occurred in the northern part of the unit, in Yellowstone National Park (see Harvey *et al.* 2016, fig. 1). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to continue to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction on lands with developmental allocations. Much of this unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental allocations. Even in areas with developmental allocations, the moist subalpine forests important to lynx have had less timber harvest and road construction, and have been modified much less than other drier forests (65 FR 16073). These activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx. Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Wyoming (1 [a Colorado-released lynx]; USFWS 2016c). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2). However, whether, and if so to what the extent, the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. Although this unit is not directly connected to lynx habitats and populations in Canada or elsewhere in the contiguous United States, no barriers to lynx dispersal from the north have been identified, and 9 lynx released in Colorado are known to have dispersed northward into and through this unit (Devineau *et al.* 2010, p. 526; Ivan 2017, entire), demonstrating that dispersal between the southern and northern Rockies is possible. As described above in Lynx Status, the large number of lynx reportedly trapped from a small area of the Wyoming Range in the early 1970s (Squires and Laurion 2000, p. 338) may suggest dispersers associated with the irruption of many lynx from Canada into the northern contiguous United States documented at that time (McKelvey *et al.* 2000a, pp. 235-242). No subsequent pulses of lynx dispersing from the north have been documented, and lynx trapping records suggest that the magnitude of lynx populations cycles in Alberta and British Columbia, the most likely source of lynx dispersing southward into this unit, dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Bowman *in* Lynx SSA Team 2016a, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5[24]).

[24] https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf.

As described in section 3.2, a number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous United States. If lynx populations in this geographic unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and a reduced likelihood of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, it is possible that it has contributed to the recent apparent loss of resident lynx from this unit.

4.2.6 Unit 6 - Western Colorado

Unit Description - This geographic unit includes parts of the Southern Rocky Mountains of western Colorado. It encompasses approximately 25,294 km^2 (9,766 mi^2) of potential lynx habitat distributed west of US Interstate 25, with ownership that is 90 percent Federal (85 percent USFS, 3 percent BLM, 2 percent NPS), 9 percent private, and < 1 percent State. When it listed the DPS, the Service identified 26,305 km^2 (10,156 mi^2) of potential lynx habitat in the Southern Rockies (i.e., western Colorado and south-central Wyoming; [65 FR 16052]). In 2003, we estimated 31,027 km^2 (12,419 mi^2) of potential habitat within that area (68 FR 40076). Ivan *et al*. (2011e, entire) developed a predictive map of lynx habitat by using telemetry location data collected during CPWs lynx monitoring, and then estimated the amount of habitat associated with a high probability of detecting lynx. Our review of the vegetative characteristics of CPW's predictive map detected large areas of spruce-fir habitats that were excluded by their presentation of the habitat associated with the top 20 percent of predicted use (Ivan 2011e, p. 26). Therefore, we selected the top 30 percent of predicted use areas and the associated habitat to represent the amount of potential lynx habitat in this unit. Our estimate of potential habitat (above) falls between the Ivan *et al*. (2011e, p. 26) estimate (about 18,700 km^2 [7,220 mi^2]) and the USFS's habitat estimate (30,664 km^2 [11,839 mi^2]; USFS 2008b, p. 18), while retaining a greater than 60 percent probability of detecting lynx as described by Ivan *et al*. (2011e, pp. 32-33).

We excluded the northwest part of the State, bounded on the south by US Interstate 70 and the east by Colorado State Highway 13, because this area lacks sufficient habitat to support lynx. Small areas of similar potential lynx habitat extend into south-central Wyoming and north-central New Mexico, and some lynx released in Colorado traveled into or through those areas. However, there is no evidence that either area supports resident lynx, and we doubt their ability to do so. This unit is not directly connected to lynx habitats and populations in Canada or to other DPS populations, although lynx dispersing from the north apparently arrived intermittently into the area historically, and long-distance dispersal (emigration) of translocated lynx from this unit to many western states and to Canada have been documented. The Southern Rockies are separated from the rest of the Rocky Mountain chain, and thus from lynx habitat in northwestern Wyoming and further north, by sagebrush and desert shrub communities in the Wyoming Basin and the Red Desert of southern and central Wyoming, and the arid Green and Colorado River plateaus of western Colorado and eastern Utah. Because of extreme topographic relief

juxtaposed with highways, residential communities, and other human developments, lynx biologists have identified habitat connectivity as an important consideration for the Southern Rockies (ILBT 2013, p. 54). Relative to other DPS lynx populations, this unit is about 400 km (250 mi) southeast of the GYA geographic unit.

Habitat Description - Lynx habitat in the Southern Rockies occurs within the subalpine and upper montane forest zones, generally above 2,900 m (9,514 ft) elevation (Shenk 2009, p. 10). In the upper elevations of the subalpine zone, forests are typically dominated by subalpine fir and Engelmann spruce. As the subalpine zone transitions to the lower-elevation upper montane zone, spruce-fir forests begin to give way to lodgepole pine and aspen. On cooler, mesic mid-elevation sites, Engelmann spruce may retain dominance, intermixed with aspen, lodgepole pine, and Douglas-fir. Lodgepole pine reaches its southern limits in the central part of the geographic unit, while southwestern white fir occurs only in the San Juan Mountains. The lower montane zone is dominated by ponderosa pine and Douglas-fir, with pines typically dominating on lower, drier, more exposed sites, and Douglas-fir occurring on the more sheltered sites. Lower montane forests do not support snowshoe hares and are seldom used by lynx except during dispersal and exploratory movements.

In this unit, lynx most commonly use mature Engelmann spruce-subalpine fir forests with total canopy cover of 42–65 percent and a conifer understory canpoy of 15–20 percent, followed by mixed forests of Engelmann spruce-subalpine fir-aspen (Shenk 2008, p. 15; ILBT 2013, p. 52). Riparian and riparian-mix are the third most-used cover type, with a pattern of increasing use beginning in July, peaking in November, and dropping off in December. Large or medium willow-alder carrs and willow riparian communities provide important habitat for snowshoe hare, grouse, ptarmigan (winter), and other prey species (ILBT 2013, p. 52).

Habitat Status - Snowshoe hare (lynx foraging) habitat is naturally patchily-distributed in the Southern Rocky Mountains (ILBT 2013, p. 54), limiting hare abundance in this geographic unit. Dolbeer and Clark (1975, pp. 535, 539) estimated snowshoe hare density at 0.73 hares/ha (0.3 hares/ac) in Summit County in central Colorado, with the highest densities in mature and late-successional spruce-fir forests. However, this study was conducted in a very limited area and did not sample younger sapling-stage stands (15-40 years post-disturbance) to compare hare densities with those reported for mature and late-successional spruce-fir forests (USFWS 2008b, p. 32). Zahratka and Shenk (2008, pp. 910-911) estimated higher hare densities in mature Engelmann spruce-subalpine fir stands (0.08 to 1.32 hares/ha ([0.03 to 0.5 hares/ac]) than in mature lodgepole pine stands (0.06 to 0.34 hares/ha [0.02 to 0.14 hares/ac]) in Taylor Park, Colorado. In contrast, Ivan *et al*. (2014, p. 587) estimated highest (summer) hare densities in early (20-25 years old) seral lodgepole stands (0.2 to 0.66 hares/ha [0.08 - 0.27 hares/ac]); intermediate densities in mature spruce-fir stands (0.01 to 0.26 hares/ha [0.004 - 0.1 hares/ac]); and lowest densities in mid-seral (40-60 years old) lodgepole stands that had been pre-commercially thinned (0.01 to 0.03 hares/ha [0.004 - 0.01 hares/ac]). Densities were more similar across the 3 forest types during the winter months; however, in all forest types and all seasons, hare densities were < 1.0 hares/ha (< 0.4 hares/ac) and in most cases were < 0.3 hares/ha (< 0.12 hares/ac; Ivan *et al*. 2014, p. 589). In fact, only 1 stand type (early seral

lodgepole) in 1 summer (2006) had an estimated density (0.66 ± 0.14 hares/ha [0.27 ± 0.06 hares/ac]) that exceeded the 0.5 hares/ha (0.2 hares/ac) threshold suggested as a minimum needed to support resident lynx over time (Ivan *et al*. 2014, p. 587, fig. 2). The information summarized above suggests that hare densities in this unit are low to marginal compared to units that have historically supported persistent resident lynx populations, and they may be inadequate to support long-term lynx persistence.

Colorado is currently experiencing historically unprecedented bark beetle epidemics in lodgepole pine and spruce-fir forests. By 2015, the spruce beetle outbreak influenced approximately 95 percent of the mature spruce component of the subalpine cover types on the Rio Grande National Forest (Squires *et al.* 2016, *unpubl. report*, p. 1), which contains most of the potential lynx habitat in the San Juan Mountains. Recent statewide sampling, however, indicates that snowshoe hare occupancy is invariant to time since beetle outbreak or severity of the outbreak (Ivan and Seglund 2016, pp. 2, 5), which suggests that the ongoing epidemic will not be catastrophic to lynx in Colorado. However, red squirrels are an important alternate food source in this unit, and occupancy of that species has declined markedly with the beetle epidemic (Ivan and Seglund 2016, pp. 2-3), which may be of some concern during periods when snowshoe hare abundance naturally fluctuates downward.

All USFS land management plans within the unit were amended by the SRLA in 2008 to provide for the conservation of lynx (USFS 2008a, entire; USFWS 2008b, entire). In 2008, the USFS reported that most LAUs on National Forest System lands in the Southern Rockies fell within a range of 3-8 percent in a currently unsuitable condition, with only 1 LAU exceeding the 30 percent unsuitable threshold established in the SRLA (USFS 2008b, p. 19). Currently, the USFS reports that 51 of 202 LAUs (25 percent) exceed the 30 percent unsuitable condition (McDonald 2016, *pers. comm.*). These changes are mostly in response to the ongoing bark beetle infestations and wildfires that have occurred since 2008. No forest management activities have resulted in LAUs exceeding the threshold.

Similarly, since the DPS was listed, all BLM Field Offices (FOs) in Colorado have been conserving lynx discretionarily through application of conservation measures provided in the LCAS (Ruediger *et al.* 2000, entire; ILBT 2013, entire). Three BLM FO plans in Colorado have been amended or revised to conserve lynx following the 2013 LCAS on lands totaling approximately 126 km^2 (49 mi^2) of potential lynx habitat. One additional FO plan provides conservation measures for timber management actions only, but that FO administers only about 1 km^2 (0.39 mi^2) of potential lynx habitat. To date, the remaining FOs have not formally amended or revised their plans specifically to provide conservation for lynx. Combined, these plans guide management of approximately 645 km^2 (298 mi^2; about 2.6 percent of the geographic unit) of potential lynx habitat. Additionally, Rocky Mountain National Park has a fire management plan that includes conservation measures for lynx (Wrigley 2016, *pers. comm.*; Watry 2016, *pers. comm.*), although resident lynx have not been confirmed in the park. We are not aware of any specific lynx conservation strategies guiding activities on non-Federal lands in this geographic unit.

Lynx Status - The current number and distribution of resident lynx in Colorado are somewhat uncertain. However, experts suggest there may be 100-250 lynx in this unit, and we believe it is reasonable that lynx continue to occur in all national forests within the State. As of 2007, average annual survival among released lynx was 0.93 ± 0.03 within the study area in the San Juan Mountains and 0.82 ± 0.07 outside the study area boundary (Devineau *et al.* 2010, p. 5). Although 30 percent of known mortalities were due to human causes (being shot or hit by a vehicle; Devineau *et al.* 2010, p. 5), the estimate of survival within the study area was higher than those reported for natural, lightly trapped populations of lynx in the Yukon (0.75–0.90; Slough and Mowat 1996, entire; O'Donoghue *et al.* 1997, p. 155) or in the Northwest Territories (0.90; Poole 1994, p. 612). Successful reproduction, including by third- and fourth-generation offspring of translocated lynx, has been documented (Shenk 2008, p. 2); however, the average proportion of females that produced kittens (24 percent; Ivan *in* Lynx SSA Team 2016a, p. 22) and the kitten survival rate (0.23; Ivan 2016b, *pers. comm*.) were both lower in this geographic unit (during the period of intensive monitoring from 1999-2010) than rates reported for other geographic units where estimates were based on adequate sample sizes (Units 1 and 3; table 4).

The CPW has developed a minimally-invasive, long-term, state-wide monitoring program to track the distribution, stability, and persistence of lynx in Colorado (Ivan 2011e, entire) that may also eventually provide population trend information. As of 2016, this monitoring program detected evidence of recent lynx reproduction via camera captures of kittens accompanying adult females at 3 locations during the 2014-2015 and 2015-2016 monitoring efforts (Ivan *et al*. 2015, p. 1; Odell *et al*. 2016, p. 6). In addition, 38 percent of lynx captured during recent (2010-2015) RMRS research projects in Colorado have been young and/or unmarked cats (Ivan *in* Lynx SSA Team 2016a, p. 17), suggesting continued reproduction within Colorado. However, current reproductive rates are unknown. Finally, despite the large scale and almost complete mortality of the mature spruce component within the core release area of the San Juan Mountains, lynx continue to use and reproduce in the beetle-infested forests (Squires *et al.* 2016, *unpubl. report*, p. 2).

Factors Affecting Current Conditions

Regulatory mechanisms to conserve lynx habitats in Colorado are largely provided through Forest Service planning documents, as described above under Habitat Status. Because the majority (88 percent) of potential lynx habitat in Colorado is under Federal land management, actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. However, habitat connectivity may be negatively affected by intense recreational use or development in key areas that are important for habitat connectivity, although this isn't a widespread phenomena or threat.

Although bark beetles are native insects and forests in the western United States have experienced regular insect infestations throughout their history, the current bark beetle epidemic is notable for its intensity and extensive geographic range. The causes of this epidemic include: relatively even-aged, dense, and homogenous forest conditions, which are highly susceptible to beetle attack, and which were created by large-scale logging in the late 1800s and subsequent

fire suppression efforts; warmer winters as a result of climate change (cold winters typically reduce beetle populations); and a multi-year drought that occurred in the mid-1990s through early 2000s, stressing the trees and making them more susceptible to beetle attack (USFS 2011b, p. 4).

In lodgepole pine forests, a mountain pine beetle epidemic typically kills the entire overstory and results in a stand-replacing disturbance event. In Colorado, more than 13,759 km^2 (5,312 mi^2) have been affected by mountain pine beetle and 6,390 km^2 (2,467 mi^2) have been affected by spruce beetle since 1996 (USFS 2015b, p. 3), a portion of which overlaps potential lynx habitat in this geographic unit. Even-aged mature and "dry" lodgepole pine stands characteristically have depauperate understory vegetation and are not capable of supporting dense populations of snowshoe hares. On moist sites, regeneration of beetle-killed lodgepole pine stands is expected to be relatively rapid (20-30 years), and the new stands will be dominated by a regenerating cohort of lodgepole pine or resprouting aspen. If these newly-established stands grow tall and dense enough to provide horizontal cover above the snow layer, they may produce excellent habitat for snowshoe hares and lynx for several decades, until the crowns again lift above the reach of snowshoe hares.

A spruce beetle epidemic kills the larger-diameter trees and can also result in a stand-replacing disturbance event. Because of the importance of spruce-fir forests for production and survival of snowshoe hares, widespread mortality of mature spruce-fir forests could impact lynx habitat for a long time.

ILBT (2013 p. 57; 61-62) states:

> *Plague, a flea-borne disease caused by the bacterium Yersinia pestis, which is not native to North America, was reported for the first time in lynx in Colorado (Wild et al. 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 reintroduced lynx between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to Y. pestis; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado.*
>
> *Vehicular collisions are a potentially important cause of mortality for lynx in portions of the southern Rockies. Thirteen of 102 mortalities documented for lynx translocated into Colorado were from vehicle collisions (Devineau et al. 2010). Brocke et al. (1990) suggested that translocated animals might be more vulnerable to highway mortality than resident lynx and this could have been a factor in Colorado at the time of listing. Currently, the majority of lynx mortalities caused by vehicle collision (13 of 16) occurred during the reintroduction period (1999-2006). Since early 2007, one year after the final reintroductions occurred, only 3 hit by vehicle mortalities have been reported, and only two of those occurred in Colorado (Broderdorp unpublished data 2016). A number of highways with high speed and high traffic volume pass through lynx habitat, such as I-70, I-80, US 50, US 550 and US 160. These highways are not a barrier to lynx movement, as repeated successful crossings by radio-telemetered lynx have been*

documented on I-70 and Highways 9, 40, 50, 91, and 114 (Ivan 2011b, c, 2012; J. Squires, personal communication 2012). At this time, it appears that hit by vehicle mortality may be a less significant mortality factor for lynx in Colorado.

As compared with other portions of the range of lynx, in Colorado more winter recreation and associated development overlaps with lynx habitat. Preliminary information from a study in Colorado indicates that some winter recreation uses may be compatible, but lynx may avoid some developed ski areas (J. Squires, personal communication 2012). It is possible that ski areas and 4-season resorts may reduce the amount and availability of lynx habitat within localized areas, in part by influencing the distribution or abundance of prey resources within the developed area. However, there is also considerable anecdotal evidence of lynx using ski areas.

Leg-hold trapping is currently prohibited under the state constitution of Colorado as a means of predator control or for commercial and recreational trapping. If a landowner can prove that all other non-lethal methods have been ineffective, a 30-day exemption may be granted for depredation cases. Incidental trapping mortality of lynx may be a minor risk during trapping seasons in southern Wyoming and surrounding states.

Predator control activities on federal lands, including coyote shooting or trapping, are common throughout most of this geographic area, mostly related to the grazing of domestic sheep. The majority of sheep grazing occurs on arid rangelands, but some grazing does occur during summer at the higher elevations, especially in south-central Colorado. Incidental capture of lynx is possible, but unlikely.

In summary, there are currently many more resident lynx in this unit than likely occurred historically, and many more than were known or suspected at the time the DPS was listed. There were even fewer verified records in this unit during the last century than in the GYA, and no reliable evidence of a resident breeding population. However, from 1999-2006, 218 Canadian and Alaskan lynx were released into the San Juan Mountains of southwestern Colorado. As a result of the subsequent reproduction of some of the released lynx and some of their offspring over several generations, resident lynx currently occupy this unit. When the DPS was listed in 2000, 27 of 41 radio-marked lynx released in 1999 were still alive. The State of Colorado has concluded that its efforts have established a viable lynx population, and the State's lynx experts suggest this unit may currently support 100-250 resident lynx (Ivan *in* Lynx SSA Team 2016a, p. 47). Recent (2010-2016) snow-tracking and camera surveys in the San Juan Mountains in the southern part of the unit documented evidence of continued lynx residency and reproduction.

Chapter 5: Future Conditions

In this chapter, we present our assessment of the future condition of the lynx DPS in terms of redundancy, representation, and resiliency. Given the uncertainty about the historical distribution of resident lynx in the contiguous United States and the current lack of reliable

estimates of the sizes, trends, and many demographic parameters for most DPS populations, it is difficult to confidently predict the future condition of the DPS or the likelihood that any given geographic unit will support resident lynx in the future. We lack data to build rigorous empirical population models for lynx across the DPS range, and uncertainty regarding the timing and magnitude of potential impacts to lynx from continued climate warming also limits our ability to predict the future condition of the DPS. Therefore, our assessment of the future condition of the DPS is based on our evaluation of the available scientific information regarding the factors identified by the ILBT as the most likely to have population-level impact to lynx in the DPS (ILBT 2013, pp. 68-78) and on the best professional judgments and opinions of lynx experts.

We provide brief summaries of the possible future conditions in each geographic unit, followed by a more detailed evaluation of the factors likely to influence lynx populations and habitats in each unit. We present and summarize the professional judgments and opinions of a panel of 10 lynx experts regarding the factors likely to influence the persistence of resident lynx populations in each of the 6 geographic units. We also present and summarize the experts' projections, based on consideration of those influencing factors, of the probability that each of the geographic units will continue to support resident breeding populations of lynx into the future (at years 2025, 2050, and 2100), and the sources of uncertainty that influenced their confidence in their predictions. Although we did not ask experts to evaluate different specific scenarios (e.g., climate models using different greenhouse gas emissions scenarios), we did ask them to provide the highest and lowest probabilities that each unit would continue to support resident lynx populations in the future, in addition to what they considered the "most likely" probability (see figs. 9-15, below).

Formal elicitation of expert opinion where empirical information is unavailable or inadequate is an appropriate and scientifically supported approach (Morgan 2014, entire). However, we remind readers that the output remains the experts' best professional judgment, which is subjective and, therefore, inherently different than experimentally collected data subjected to rigorous statistical analyses. For purposes of useful and meaningful presentation and comparison among geographic units, it was necessary to combine, quantify, graph, and summarize the qualitative information provided by experts. However, we caution that the results we present below and describe more fully in this chapter should not be interpreted as precise, statistically robust estimates of the probability that resident lynx will persist in the DPS or in any individual geographic unit in the future. Readers should consider the inherent limitations and substantial uncertainties in expert responses, particularly over longer time periods.

After summarizing experts' inputs, we then present our evaluation of the scientific literature regarding how certain anthropogenic factors may influence future conditions for resident lynx in each geographic unit. The factors we consider for each geographic unit include regulatory mechanisms (the factor for which the DPS was originally listed under the ESA) and the anthropogenic influences identified by the Interagency Lynx Biology Team (ILBT) as having the potential for population-level impacts to lynx in the DPS (climate change, vegetation management, wildland fire management, and habitat loss/fragmentation; ILBT 2013, pp. 68-78; see also chapter 3, above). Other factors were also evaluated for some geographic units if the

Core Team member most familiar with that unit felt those factors could pose meaningful, even if less likely, risks to the unit's continued ability to support resident lynx. After considering all of the above, we present our conclusions regarding the future conditions for resident lynx populations in each geographic unit and we discuss the extent to which our conclusions agree with or differ from the projections provided by the lynx expert panel we consulted and, if they differ, why.

Implicit in our evaluation of the future for lynx in the contiguous United States is our recognition and consideration of a possible future in which the DPS is not listed under the ESA. However, given (1) the history of lynx management, research, monitoring, and habitat conservation efforts by State wildlife and natural resource agencies in most states throughout the DPS range; (2) similar efforts by Federal land managers and related formal amendments or revisions to their land management plans to address the threat for which the DPS was listed (the inadequacy of previous regulatory mechanisms); (3) Tribal wildlife conservation efforts and philosophies; and (4) the DPS's listing and consultation history, we do not evaluate the unlikely hypothetical future in which all protections and conservation efforts would disappear if the DPS was not listed. Rather, although some protections could be relaxed (e.g., less stringent analyses of project-related impacts, potential for some states to reinstitute limited trapping harvest), we assume that Federal, State, and Tribal agencies and some private landowners would continue to manage for the conservation of resident lynx populations in those places that can support them in the DPS range. Our evaluation, therefore, considers the possibility of future relaxing of some lynx conservation measures and efforts, but not the complete absence of all protections for lynx. Some of the experts we consulted indicated that their projections assumed the status quo (i.e., continued protections under the ESA and current Federal and State land management policies). Others indicated their projections were not influenced by regulatory considerations but that doing so would not have altered their estimates; they felt that factors influencing lynx persistence on the landscape are independent of ESA listing status (Lynx SSA Team 2016a, p. 52).

As mentioned above, we do not define and evaluate specific and explicit climate change or greenhouse gas emissions scenarios or attempt to quantify differences in DPS viability or the persistence of resident lynx populations in individual geographic units based on differences in the rate and extent of potential impacts associated with projected continued climate warming. This is because of the limited resolution and inherent uncertainty of available climate models and the inadequacy of existing demographic data for projecting lynx population sizes and trends in the DPS over time, including their potential responses to a range of climate-mediated potential future habitat conditions. Therefore, this SSA does not constitute or include a formal climate change vulnerability assessment (Glick *et al*., editors, 2011, entire) for the lynx DPS. Instead, underlying our evaluation in this SSA is the recognition that the lynx, as a broadly-distributed boreal forest-and snow-associated predator that relies heavily on a single, similarly-specialized prey species, and whose habitats are naturally influenced by climate-mediated disturbance factors (e.g., wildfire, forest insects, wind/ice storms, etc.), is likely highly sensitive and broadly exposed to the impacts of climate change and has limited adaptive capacity to respond to it. Therefore, we (along with the experts we consulted and the ILBT) consider lynx populations in the DPS vulnerable to the projected impacts of continued climate warming. While

we recognize that the pace and extent of impacts would be expected to differ under specific emissions or modeling scenarios, the limitations described above preclude us from quantifying those differences and their potential influence on the likelihood that resident lynx will persist in the DPS or in individual geographic units.

5.1 Summary of Future Conditions DPS-wide

Overall, our evaluation of the scientific literature and expert input suggests that resident lynx populations are likely to persist in each of the geographic units where they currently occur in the near-term (though year 2025), and in all or most of those units at mid-century (year 2050; see table 1, above, and figs. 9-15, below). Over the longer-term (out to year 2100 and beyond), populations in each of the geographic units and, therefore, in the DPS as a whole, are likely to be smaller and their distributions reduced. These anticipated declines are likely to be most influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations; Lynx SSA Team 2016a, p. 58). This outcome seems likely regardless of which climate emissions scenario is used to model future conditions, although the timing, extent, and magnitude of impacts is uncertain and would likely vary by scenario.

In addition to climate change, forest management also has the potential to influence (negatively or positively) hare and lynx habitats in the DPS range. Forest management on private lands that lack lynx conservation commitments may contribute to future declines in the amount and quality of lynx habitats, particularly in Maine and perhaps also in Minnesota (private lands contribute minimally to lynx habitats in the other geographic units – see table 2 in chapter 1). Uncertain future forest ownership and markets for forest products, shifts in silvicultural practices, and development pressures on private lands all may affect the resiliency of future lynx populations in these 2 units. Increased frequency, size, and intensity of wildfires and forest insect outbreaks, both driven by climate warming, are of concern for western geographic units.

Although all 5 geographic units that currently support resident populations (all units except the GYA) are, individually, expected by lynx experts (based on the median of experts' "most likely" persistence probabilities) to continue to do so at 2025 and through 2050, only 1 unit (Northwestern Montana/Northeastern Idaho; Unit 3) had an expert-estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century (see fig. 12, below). Expert input suggests that all other geographic units individually have a 50 percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century, although all experts expressed substantial uncertainty regarding projections that far into the future (figs. 10, 11, and 13-15, below; also see Lynx SSA Team 2016a, pp. 36-49).

Cumulatively, expert responses suggest a high (about 80 percent) "most-likely" probability that resident lynx populations will persist in all 5 units that currently support them (all units except the GYA) in the near term (year 2025; see fig. 9, column 2; row 2, below). Expert responses

similarly suggest a high (80 percent) likelihood that at least 4 of the 5 units will continue to support resident lynx at mid-century, and a cumulative probability just under 50 percent that all 5 will do so (see fig. 9, column 2; row 3, below). Over the longer term, expert responses cumulatively suggest a high (about 85 percent) likelihood that at least 2 of the 5 units will support resident populations at the end of the century; a more than 50 percent likelihood that 3 units will do so; but also a high (> 75 percent) likelihood that resident lynx populations will be functionally extirpated from 2 of the 5 units that currently support them by the end of the century (see fig. 9, column 2, row 4, below; see Cummings, 2016, pp. 6-20 for details on the data and software used to generate figs. 9-15, below). The experts we consulted expect the likelihood that lynx populations will persist to decline in each geographic unit in the future, although uncertainty increases with time from the present, and increases greatly for end-of-century projections (Lynx SSA Team 2016a, pp. 36-49; also see 5.2).

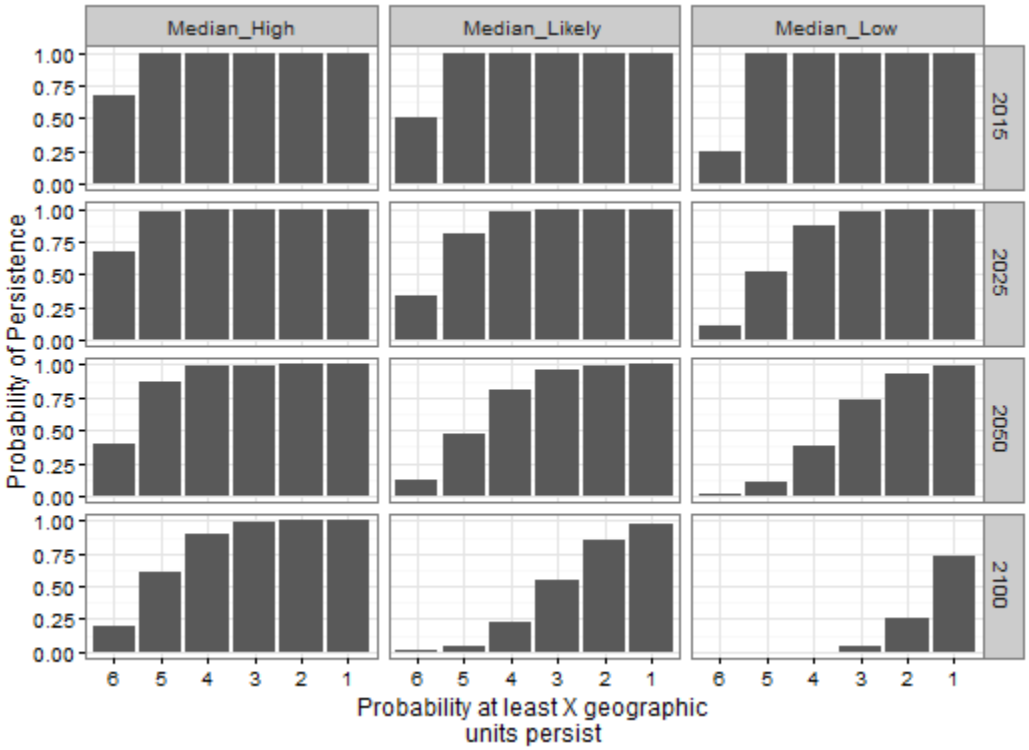


Figure 9. Summary of lynx experts' predictions regarding the probability of persistence of at least a given number of geographic units given the probability of persistence for each individual geographic unit. The y axis of each grid in figure 9 is the probability that at least the number of geographic units indicated by the x axis of the grid persist. The probability in a bar reaches 1 when there is no probability of fewer geographic units persisting. Moving from top to bottom, the grids show the probabilities by time period (2015 [current at time of expert elicitation], 2025, 2050, and 2100). Moving from left to right the grids show the range of expert responses by summary selection type and probability response. Therefore, looking down a column of grids provides a view of the trend in persistence through time and looking across a row of grids provides a view of the range of uncertainty in expert projections of persistence for a given time period.

Our evaluation generally concurs with the expert input we received. We believe that lynx populations and habitats in the DPS will decline over time largely as a result of continued climate warming and associated impacts, which are likely to exacerbate the potential adverse effects of other factors (e.g., forest management, potential increased competition from other hare predators). We acknowledge that under a "worse case" climate modeling scenario the boreal and subalpine forests and snow conditions associated with lynx occupancy could completely or largely disappear from some units (e.g., Minnesota; Galatowitsch *et al*. 2009, pp. 2015-2016) and be substantially reduced in the remainder before the end of the century. However, we are aware of no climate modeling that suggests the complete disappearance of potential lynx habitat from the entire contiguous United States by the end of the century. Complete loss of lynx habitat is perhaps more likely in the Northern Maine and Northeastern Minnesota units where there is little potential for elevational refugia compared to the more topographically diverse units (3 through 6) in the western United States. Under such a scenario, resident lynx would be unable to persist in some units and would be severely restricted in number and distribution in others, with any remaining resident populations more vulnerable to demographic and environmental stochasticity, genetic drift, and catastrophic events than they are currently.

Conversely, under a "better case" climate scenario (perhaps combined with a "better case" future forest management scenario), it is possible that resident lynx could continue to persist through the end of the century in all 5 geographic units that currently support them. Even under this scenario, however, we would expect smaller population sizes and reduced distributions in each unit resulting from the impacts of even moderate continued climate warming. We are aware of no models that predict climate cooling or climate-mediated improvement in lynx habitat conditions in the contiguous United States over the next century. We cannot quantify the likelihood of either of these extreme scenarios nor improve the accuracy or precision of, or our confidence in, the experts' predictions regarding persistence.

Considering this range of potential future climate conditions, associated uncertainties, and expert input, we conclude that over the short-term (through year 2025), resident lynx populations are very likely to persist in all 5 geographic units that currently support them. We likewise conclude they are likely to persist in the mid-term (through 2050) in all or most geographic units that currently support them, with corresponding maintenance of redundancy and representation, despite reduced lynx numbers and distribution and, therefore, reduced resiliency among all or most populations. Recognizing the high level of uncertainty associated with predications beyond mid-century, we nonetheless conclude it is very unlikely that resident lynx populations will persist through 2100 in all 5 of the geographic units that currently support them. That is, we believe that resident populations will likely persist at the end of the century in 2 or 3 of the 5 units that currently support them, but that resident populations may be functially extirpated from 2 to 3 of the units by then. Even where populations persist, they will be reduced in number and distribution and, therefore, resiliency.

The loss of viable resident lynx populations from 1 or more geographic units would represent reduced future redundancy, representation, and resiliency within the lynx DPS. With regard to

redundancy, however, our evaluation of the scientific literature and expert input indicates that no individual geographic unit that currently supports resident lynx is vulnerable to extirpation from a single catastrophic event. Given that, we conclude that the DPS as a whole is not vulnerable to extirpation from a catastrophic event (i.e., we find that there is a zero probability that a single catastrophic event could result in extirpation of resident lynx from any of the 5 geographic units that currently support them and, therefore, a zero probability of catastrophic extirpation of the entire DPS). As described above (section 1.3), we do not consider continued anthropogenic climate warming a catastrophic event; rather, we consider it a systemic, ongoing, and pervasive stressor, not a single temporally- and spatially-discrete event. We recognize that a sequence of discrete but spatially-clustered catastrophic events in lynx habitats over a short time could increase the potential for functional extirpation in 1 or more of the individual geographic units (especially the possibility of additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in 1 or more units within the DPS, extirpation of the DPS from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, and the current and likely future connectivity and absence of significant barriers to dispersal between Canada and most DPS geographic units. Based on these factors and expert input, we find that there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (Lynx SSA Team 2016a, p. 51) and no indication that future gene flow is likely to be substantially reduced (79 FR 54793). This information suggests the current and likely future relative genetic health of the DPS. However, as noted in section 2.2, the potential for genetic drift among DPS populations would be expected to increase at some point in the future if lynx and hare habitats shift northward and upslope, as projected with continued climate warming, resulting in reduced connectivity and gene flow among smaller and more isolated lynx populations at the periphery of the range. This would result in (1) smaller and more distant potential source populations, reducing the likelihood and number of immigrant lynx reaching DPS populations, and (2) smaller effective population sizes among DPS populations, making them more vulnerable to drift, the consequences of which could include lower survival and reproduction rates and loss of adaptive potential.

How the potential loss of resident lynx from 1 or more geographic units may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, the amount of snow that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr [106 in/yr]) is almost twice that observed in Minnesota (140 cm/yr [55 in/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, younger regenerating stands are most important. The

loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Because resident lynx populations in all geographic units that currently support them are expected to become smaller and more fragmented and isolated, each geographic unit and the DPS as a whole will be less resilient in the future. Our analyses and expert input suggest that resiliency will likely be sufficient to foster persistence of resident lynx in most units through mid-century but that its declining trajectory over time could result in extirpation of resident populations from 2 to 3 (of 5) units by the end of the century. Projected continued climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare and lynx reproductive and survival rates are likely to decrease, resulting in population declines in both species. As snow conditions become less favorable, competitors (e.g., coyotes and bobcats) may outcompete and displace lynx. This in turn would reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

5.1.1 Summaries of Future Conditions in Each Geographic Unit

Unit 1 – Northern Maine: Although the Northern Maine geographic unit currently has extensive lynx habitat, the amount and distribution of high-quality habitat is projected to decline over the next 2 to 3 decades. Forestry practices, climate change, habitat loss and fragmentation, spruce budworm outbreaks, and development are most likely to drive future hare and lynx habitat in this unit. Lynx habitat and lynx densities are expected to decline by 50 to 60 percent by 2032 in response to aging of the budworm-era clearcuts and the effects of extensive partial harvesting since the 1989 passage of the Maine Forest Practices Act (Simons 2009, pp. 209, 217). In the next few decades, high-quality hare habitat is projected to decline from about 10 percent to 5 percent of the landscape (Simons-Legaard 2016, fig. 8, p. 10), perhaps more in line with likely historical conditions. High-quality habitat patches will likely become more fragmented, smaller, and more isolated, thus making the landscape less suitable for lynx than it currently is. For the next few decades the best habitat (young regenerating stands) will occur in the southern portion of current lynx distribution, where effects of climate change and potential competition with bobcats are likely to be greatest (Simons-Legaard *et al*. 2016, p. 1267). Absent long-term lynx management agreements, the future of lynx habitat in this unit is uncertain. Wood products markets will likely continue to change and could be affected by interest in carbon sequestration in response to climate change, with potential consequences for forest management in this unit. Recent rapid changes in private forest land ownership are likely to continue and could result in

subdivision of large ownerships. Non-forestry land uses (wind energy development, transmission line corridors, residential and resort development, and unmanaged conservation lands) may compete with forest management as the primary future land use. Conservation easements will limit development pressures in some areas and keep some lands as working forest, but forest practices (e.g., partial harvesting, northern hardwood management) may not create new lynx habitat or maintain the current historically high amount of high-quality habitat. Climate change is expected to affect this unit more than some others in the DPS because snow amount and duration already seem to be at thresholds for lynx and there are few potential elevational refugia. In the near term and beyond, snow quantity and quality will likely continue to deteriorate, which could cause lynx range to contract northward.

Our review of the published literature and input from lynx experts lead some members of the SSA Core Team to conclude that lynx could become extirpated from this unit before the end of the century. Climate change, increasing demand for hardwood forest products, a pending spruce budworm outbreak, and frequent forest disturbance all will likely contribute to the trend in the loss of spruce-fir forest and expansion of northern hardwoods, although the timeframe for conversion is uncertain. The lynx experts we consulted indicate the likelihood that resident lynx will persist in this unit will decline to about 50 percent by the end of the century, although there was wide variation and much uncertainty in opinions. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, lack of elevational refugia), some members of the Core Team were more pessimistic about the future of lynx in Maine than the lynx expert panel. In particular, we observed that there is great uncertainty about the future of forest management and future development on private forest lands. The lack of forest planning for lynx was not perceived or defined as a threat for this area when the DPS was listed. Nonetheless, forest management practices clearly have influenced that amount of high-quality lynx habitat and thus lynx numbers in this unit, and they are likely to continue to influence its population in the future. Currently, there are no long-term management plans in place on most privately-owned forest lands in this unit; State forest regulations have greatly influenced harvesting practices that have reduced landscape hare densities and will likely continue to do so; markets for forest products are depressed; and forest modeling projections (under current harvest scenarios) suggest that habitat will diminish and shift southward in the near term because of post-harvest succession and recede northward over the longer-term because of continued climate warming.

Unit 2 - Northeastern Minnesota: The direct and indirect effects of climate change are expected to affect lynx into the future in Minnesota. Specifically, boreal conifer forest is projected to contract northward, resulting in increased habitat loss and fragmentation and increased isolation of Minnesota lynx with diminishing forest conditions in southern Ontario. Additionally, the quantity, quality, and duration of snow are projected to decline; potentially resulting in increased competition and hybridization with bobcats as snow conditions favorable to lynx are diminished. The likelihood that resident lynx will persist in this unit is projected to decrease over time with increasing uncertainty through the end of the century, driven in the near term by decreaseing quality, quantity and persistence of snow and over the long term from loss of spruce-fir forests. We expect the SNF will continue to implement lynx conservation measures in accordance with

its Forest Plan, thus continuing to minimize several risk factors and promote the conservation of lynx into the future. If the DPS is de-listed, the species would be placed on the Forest's Regional Forester Sensitive Species list for at least 5 years, which would give it a higher priority than other species for monitoring and management during that time. We also expect that MNFRC guidelines will remain in place into the future and that voluntary actions will continue on State and private lands. However, it is unclear on what proportion of State and private lands these voluntary actions will be implemented into the future. Further, these guidelines are generalized for listed species and give no specific direction for lynx. Taking these factors into consideration, median "most likely" probabilities of persistence generated by lynx experts were high for the near- and mid-term (> 95 percent at year 2025; 80 percent at year 2050), but declined to 35 percent (with great uncertainty) by 2100. We concur with the expert panel that resident lynx are likely to persist in this unit at 2025 and 2050. However, after reviewing the scientific literature concerning climate change projections (diminishing snow conditions, loss of boreal forest, lack of elevational refugia, and the potential for increased competition, disease, and insect outbreaks), some members of the SSA Core Team were slightly less optimistic about the long-term future of lynx in Minnesota than the lynx expert panel. The Core Team concluded that the climate-mediated conversion of boreal forest to temperate forest and the loss of favorable snow conditions could occur at a rate and extent that would result in a lower likelihood of persistence than projected by experts, including the possibility that resident lynx could be extirpated from this unit by the end of the century.

Unit 3 - Northwestern Montana/Northeastern Idaho: As in other units, climate change is projected to reduce the future amount, distribution, and quality of lynx habitat in this unit via northward and upslope contractions of favorable snow and forest vegetation conditions. This would result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Fire- and insect-related habitat losses would likely be temporary, resulting subsequently in improved habitat conditions when impacted areas regenerate the dense vegetative structure conducive to hare abundance. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit would benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Lynx experts felt that future extirpation of lynx from this unit from reduced genetic health or a catastrophic event is unlikely. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Considering the factors above, lynx experts felt this geographic unit has the highest likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence > 0.95), at mid-century (median = 0.90), and end-of-century (median = 0.78), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units. After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is likely the most secure in the DPS. We conclude that it is very likely to continue to support resident lynx in the short term (through 2025) and through mid-century, although the number of lynx, the

amount and distribution of high-quality habitat, and landscape-level hare densities are all likely to decline by mid-century as a result of continued climate warming and associated impacts. We also agree that this unit is more likely than not to support some resident lynx at the end of this century, although at that time we expect lynx numbers and distribution would be substantially reduced from the current condition and would, therefore, be more vulnerable to demographic, environmental, and genetic stochasticity and to catastrophic events, resulting in reduced resiliency.

Unit 4 - North-central Washington: Over the past 25 years, wildfires have (perhaps temporarily) eliminated or reduced the quality of about a third of lynx habitat within the North Cascades, which has significantly affected the status of and current viability of the lynx population in this geographic unit. As elsewhere, continued climate warming is anticipated to reduce the future quality and distribution of lynx habitat in Washington, potentially further exacerbating the recent losses of lynx habitat from wildfires. Projected warming may increase wildfire frequency and severity, which may result in further losses of lynx habitat. Climate change is also expected to reduce the quantity and quality of snow, potentially resulting in permanent reductions in the quantity and distribution of lynx habitat in this unit. These potential climate-driven reductions of lynx habitat could isolate resident lynx within this unit and reduce connectivity with neighboring lynx populations in the other geographic units and Canada. Continued forest management on both Federal and State lands would benefit lynx populations in Washington but is unlikely to ameliorate the potential negative effects related to climate change. Considering the recent reduction in lynx habitat and the projected impacts of climate change, experts indicated persistence probabilities of 60 to 90 percent (median = 80 percent) over the near-term (year 2025), 30 to 80 percent (median = 70 percent) at mid-century, and less than 50 percent (median = 38 percent) by the end of the century for resident lynx in this geographic unit. After considering the best available scientific information and input from lynx experts, the Core Team is generally in agreement with experts regarding the likelihood of long-term persistence of Canada lynx in this geographic unit. We expect this unit will continue to support a small resident lynx population through mid-century but that its ability to do so beyond then is questionable, and that functional extirpation of lynx from this unit by the end of the century is more likely than not.

Unit 5 - Greater Yellowstone Area (GYA): As elsewhere, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions of favorable snow and forest vegetation conditions. This would result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Because potential habitats in much of this unit already are naturally highly fragmented and perhaps only marginally capable of supporting resident lynx, and because it appears to have never supported more than a small number of residents, its ability to do so in the future is tenuous. Lynx experts felt that the small number of lynx this unit appears capable of supporting and its relative isolation from other lynx populations make it more vulnerable to genetic drift and extirpation from catastrophic events or demographic or environmental stochasticity. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles

that may influence immigration into this unit) could also reduce future lynx habitat in this unit. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit would benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Considering the factors above, lynx experts felt this geographic unit has the lowest likelihood of supporting resident lynx into the future in the near term (year 2025; median probability of persistence = 0.52), at mid-century (median = 0.35), and end-of-century (median = 0.15), with a declining likelihood of persistence and greater uncertainty with increasing time from present, as in all units. After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is the least secure in the DPS. We find that conditions for lynx in this unit are naturally marginal, both its historical and current ability to support a persistent resident lynx population are questionable, and that continued climate warming and associated impacts are likely to further diminish its already limited ability to support resident lynx. We conclude, based on the protected status (national park, designated wilderness, and non-developmental land use allocations) of vast areas and climate models that project some areas of adequate vegetation and snow conditions through the end of the century, that this unit may continue to occasionally or intermittently support a small number of resident lynx and some reproduction throughout the remainder of the century. However, we conclude that it is very unlikely to support a persistent resident population over the short-term (through 2025), even less likely that it will do so at mid-century, and it is highly improbable that this geographic unit will support resident lynx by the end-of-century.

Unit 6 - Western Colorado: Regulatory mechanisms that provide for the conservation of lynx in Colorado consist of State regulations prohibiting unauthorized take of lynx and amendments of USFS and BLM management plans, which limit vegetation management (among other things) covering approximately 85-90 percent of the lynx habitat within this geographic unit and provide guidance to limit habitat fragmentation. Climate change is expected to negatively affect vegetation and influence snow conditions in this unit. The elevation gradient in Colorado may provide refugia from deteriorating snow conditions in the future. Assuming that snow levels will increase in elevation, lynx habitat is likely to become more fragmented by areas that no longer retain appropriate snow conditions and vegetation. However, we anticipate large areas of snow persistence to remain through the end of the century. Wildland fire will likely result in temporarily reduced habitat quality to some extent; however, affected areas are likely to regenerate and provide excellent habitat conditions to support hares and lynx. Given projected climate warming, some areas that currently support snowshoe hare populations may experience vegetation type conversion that may not support snowshoe hares in the future. Considering the factors above, lynx experts felt this geographic unit has a high likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence = 0.90) and at mid-century (median = 0.80), and a reasonable likelihood of doing so at end-of-century (median = 0.50), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units. This unit would be expected to continue to support resident lynx in the future if survival and reproductive rates similar to those estimated during intensive monitoring are maintained over the long-term. However, given the lack of evidence of historical occupancy by resident populations, the naturally limited and fragmented potential habitat,

generally low hare densities, low proportions of females that produce kittens, and low kitten survival rate, along with projected impacts of climate warming on all or most of these paramenters, we are less optimistic than the lynx expert panel regarding the likelihood that this unit will continue to support resident lynx over the long-term.

Table 5, below, summarizes expert predictions of future lynx persistence and Core Team summary of factors thought likely to influence the future resiliency of lynx populations in each geographic unit.

Table 5. Expert-predicted future (2025, 2050, and 2100) persistence[1] of resident lynx populations in individual geographic units of the Canada lynx DPS and supporting evidence and uncertainties.

Geographic Unit	Median lynx expert probability of persistence (%)[2] (range [%])[3] at years 2025, 2050, and 2100	Key evidence	Uncertainties
Unit 1	2025: 96 (80-100) 2050: 80 (65-95) 2100: 50 (40-80)	• 50% decline from current habitat projected by 2032; habitat shift to the south edge of current range • Slight recovery of habitat by end of century depending on forestry trends • Continued demographic and genetic connectivity to southern Quebec, New Brunswick populations • Climate models predict deteriorating snow quality, depth and duration; more severe than other units • Little potential elevation refugia	• Future forest management trends and habitat conditions on private forest lands in Maine and Canada • Future shifts in land ownership, forest products markets, and development • Extent and pace of deteriorating snow conditions • Response of hares (pelage mismatch), bobcat, and fisher to changing snow regime • Extent and pace of spruce-fir loss • Future hare population trends • Disease and parasites in lynx • Effects of lynx trapping in Quebec
Unit 2	2025: 96 (88-100) 2050: 80 (60-90) 2100: 35 (10-60)	• Smaller population could be susceptible to stochastic effects • Habitat conditions on SNF will remain stable or improve if managed for softwoods • Continued demographic and genetic connectivity to southern Ontario populations • Climate models predict deteriorating snow quality, depth and duration; loss of boreal forest • Little elevation gradient: lake-effect snow may retain refugia to 2050 but not 2100	• Future forest management trends and habitat conditions on private forest lands in Minnesota and Ontario • Extent and pace of deteriorating snow conditions • Adequacy of immigration from southwest Ontario • Response of bobcat and fisher to changing snow regime • Rate of spruce-fir decline • Future hare population trends • Disease and parasites in lynx • Effect of lynx-bobcat hybridization
Unit 3	2025: 98 (95-100) 2050: 90 (70-100) 2100: 78 (50-90)	• Some habitat loss from increased wildfire, otherwise habitat should remain stable with USFS/BLM management • Continued demographic and genetic connectivity to southern Alberta and BC populations • Potential elevational refugia • Recent loss of small sub-population in	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks • Extent and pace of deteriorating snow conditions • Adequacy of immigration from southern Alberta and BC

		Garnet Range ● Increasing fire frequency	● Response of bobcat, cougar, coyote to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future hare population trends
Unit 4	2025: 80 (60-95) 2050: 70 (30-80) 2100: 38 (5-50)	● Habitat and population low because of recent fires; could be suscept ble to stochastic effects ● Continued demographic and genetic connectivity to southern British Columbia populations ● Elevation is not sufficient to provide long-term refugia from deteriorating snow quality, depth, and duration ● State uplisted from T to E (2016)	● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Adequacy of immigration from southern BC ● Response of bobcat, cougar, coyote to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future hare population trends
Unit 5	2025: 52 (10-70) 2050: 35 (15-60) 2100: 15 (5-50)	● Very low hare densities in much of unit ● Habitat should remain stable with USFS, BLM, and NPS management ● No direct connectivity with Canada populations; little immigration from DPS populations ● Potential elevational refugia ● Smaller population could be susceptible to stochastic effects	● Persistent vs. ephemeral historical presence ● Adequacy of immigration ● Extent and frequency of fire and insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, cougar, coyote to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future hare population trends ● Extent to which high elevation may provide climate and snow refugia
Unit 6	2025: 90 (60-100) 2050: 80 (50-85) 2100: 50 (20-70)	● Habitat loss from increased wildfire and insect outbreaks, otherwise habitat will remain stable with USFS management ● Isolation from other lynx populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Uncertainty about stability of recently-introduced lynx population	● Persistent vs. ephemeral historical presence ● Demographic and genetic effects of isolated population ● Extent and frequency of fire and insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, cougar, coyote to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future hare population trends

[1]We asked 10 recognized lynx experts to provide their estimates of the probability that resident lynx populations or subpopulations would persist in each geographic unit, even if reductions in lynx numbers and distributions were anticipated (i.e., the probability that resident lynx would *not* be functionally extirpated from the unit).

[2]Median “most likely” probabilities of persistence provided by 10 lynx experts for each geographic unit considering the current status of lynx populations and current and likely future stressors to those populations.
[3]The full range of “most likely” probabilities of persistence provided by the 10 lynx experts.

5.2 Future Conditions - Detailed Descriptions by Geographic Unit

In this section, we present and summarize the formally-elicited opinions of a panel of 10 lynx experts regarding the likelihood that each geographic unit will continue to support resident breeding lynx populations into the future (at years 2025, 2050, and 2100), the factors they think will influence lynx persistence, and the sources of uncertainty that influenced their confidence in their predictions. We then present our evaluation of factors that may influence future conditions for resident lynx in each geographic unit, our conclusions regarding future conditions in each geographic unit, and whether our conclusions concur with or differ from projections provided by the lynx expert panel we consulted.

As mentioned above, we remind readers that the text and figures presented here are intended to convey and summarize expert opinions, which are subjective. The graphs we provide are intended to illustrate individual and cumulative expert opinion and uncertainty, and to allow comparsions of projections of possible future lynx persistence among all geographic units. We do not imply, and readers should not infer, that these depictions represent statistically robust, accurate, or precise estimates of the actual likelihood that resident lynx will persist in the DPS or in any individual geographic unit in the future, and readers should consider the inherent limitations and substantial uncertainties in expert responses, particularly over longer time periods. In figures 10-15 below, responses for each lynx expert for each of the 3 probability-of-persistence levels, (i.e., highest, most likely, and lowest probabilities) are represented by the hollow red, filled green, and hollow blue points, respectively. The black X mark is the median of the most likely responses across the experts in each response year. The red, green, and blue dashed lines connect the median of the highest, most likely, and lowest probability-of-persistence responses across the experts in each response year. The edges of the gray areas were defined by the entire range of expert responses, from the largest of the highest-probability responses to the smallest of the lowest-probability responses. The median lines and gray areas are provided as a summarizing visualization to aid comprehension of the experts’ responses and their range, and should not be viewed as a substitute for individual responses or presented outside the context of the accompanying discussion. The gray area between red and blue dashed lines can be viewed as the median uncertainty across all 10 experts.

5.2.1 Unit 1 - Northern Maine

<u>Expert Projections of Lynx Persistence</u>

All of the experts that we consulted indicated an initially high and subsequently declining likelihood that resident lynx will persist in Maine through the end of the century, with uncertainty (range between lowest and highest estimates) also increasing over time (Lynx SSA Team

2016a, pp. 33-36). Climate change was an overriding near- and long-term stressor for lynx expressed by lynx experts.

Increased winter precipitation in the form of rain, reduced snow depth, and reduced snow durations were discussed by the experts. Experts believed that the effects of climate change would continue to increase as a stressor that would reduce lynx populations by mid- to end-of-century. Snow conditions would continue to deteriorate, potentially resulting in increased competition with bobcats and increased predation by fisher. We heard varying prognoses from experts regarding the speed at which climate-induced loss of spruce-fir forest may occur. The scientific literature suggests that loss of spruce-fir could occur relatively quickly in the Northeast, and several experts noted that an increase in northern hardwood composition of the forest is already occurring. One expert provided information that suggests that balsam fir could actually increase in the short-term (over the next few decades), but that the long-term prognosis is not favorable for natural spruce-fir regeneration. Decline or loss of spruce-fir could be accelerated by forest disturbance (e.g., budworm outbreaks or forest management affecting large acreages of lynx habitat annually).

In addition to climate change, lynx experts expressed a number of near-term stressors related to forest management in northern Maine. Land management objectives were uncertain because of frequent changes in private forest land ownership. Experts acknowledged uncertainty concerning the severity of and response by new landowners to future spruce budworm outbreaks. Experts believed that investment landowners are unlikely to respond to future budworm outbreaks as they did in the 1970s-80s (extensive clearcuts, herbicide application). Experts also acknowledged concerns about the effects of the aging of past clearcuts beyond conditions that support high-quality hare and lynx habitat.

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of spruce-fir forest, and potential competition from bobcats would be expected to reduce the likelihood that lynx will persist in this unit. Experts also were uncertain about whether hare numbers would rebound to past higher levels or remain at current lower levels.

Taking all of these factors into consideration, experts provided “most likely” persistence probabilities of 80 to 100 percent (median = 96 percent) in the near-term (year 2025), 65 to 95 percent (median = 80 percent) at mid-century, and 40 to 80 percent (median = 50 percent) at the end of the century (fig. 10). As they did for most other geographic units, all experts indicated an initially high and subsequently decreasing likelihood that resident lynx will persist in this unit, with uncertainty increasing substantially over time.

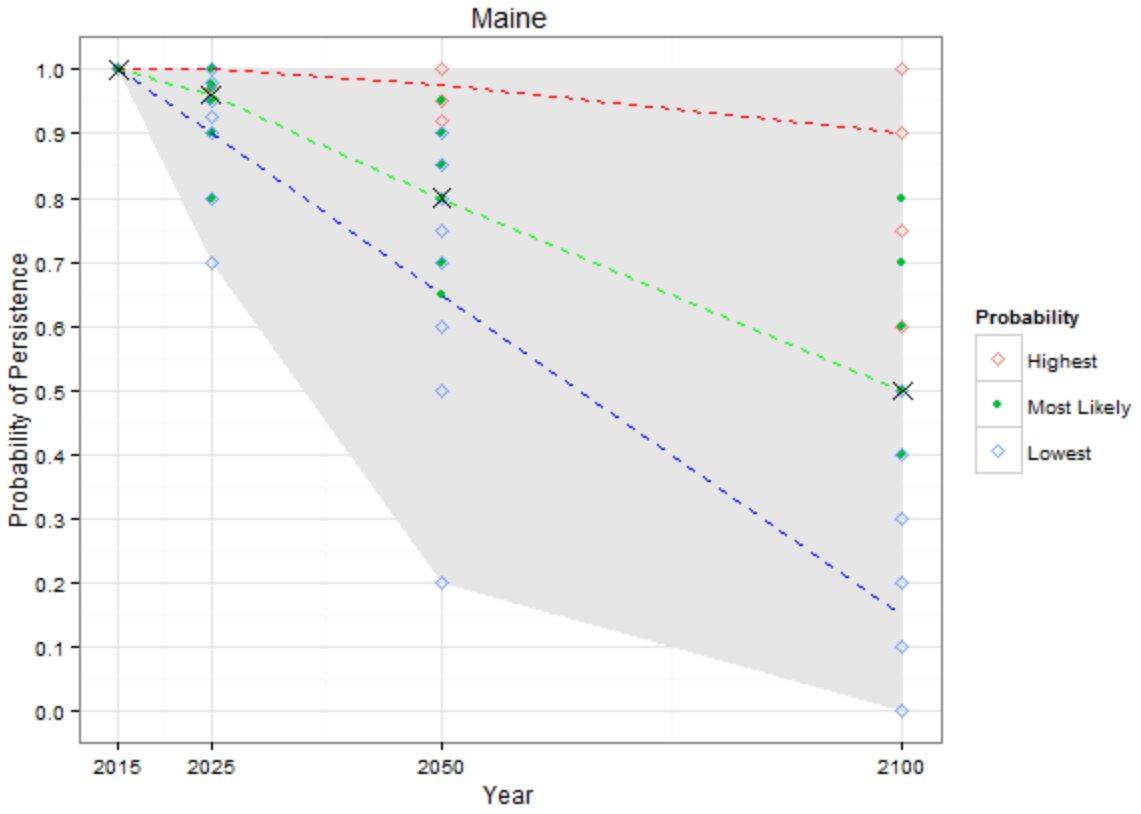


Figure 10. Lynx expert estimates of the probability that the Northern Maine Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - As described above (section 4.2.1), past forest management practices (large-scale clearcutting) have created an unnaturally high amount of high-quality hare habitat in this unit, resulting in a resident lynx population that is probably larger than typically occurred historically under natural conditions. Also as described above, a shift in forest management from clearcutting to various forms of partial harvesting that began in 1989 with passage of the Maine Forest Parctices Act (MFPA) is unlikely to maintain or recreate this extensive high-quality habitat. Therefore, we expect lynx habitat and numbers to decline in this unit over the next several decades, perhaps to levels more consistent with likely historical conditions.

If timber harvest continues using methods and at rates similar to those that have predominated since passage of the MFPA (see section 4.2.1), lynx habitat at year 2030 is modeled to decline by about 50 percent from current anthropogenically incluenced high levels (Simons-Legaard 2016, pp. 9-10). Habitat modeling indicates that the maturation of previously clearcut areas will result in a decline in high-quality hare habitat (i.e., lynx foraging habitat) in this unit from 7-12 percent of the landcape in 2010, to about 3-8 percent by year 2030, then increasing to 5-16

percent by 2060 (Simons-Legaard 2016, p. 10, fig. 8). After 2030, however, projected outcomes for lynx habitat become more uncertain and depend on assumptions about habitat definitions and harvest rates. Lynx in Maine selected for regenerating, conifer-dominated forest (> 75 percent conifer; Vashon *et al.* 2008b, pp. 1490, 1492-1494). If one defines high-qulaity lynx habitat as stands having greater than 75 percent spruce-fir, then such habitat will decline by about 50 percent by 2030 and then stabilize or increase slightly through 2060 (Simons-Legaard 2016, pp. 9,16; fig. 8).

The projections above do not consider a nearly 60 percent decline in snowshoe hare densities that has occurred in Maine from a period of high hare density in 2001-2006 (1.8 - 2.2 hares/ha [0.7 – 0.9 hares/ac] in regenerating conifer) to a period of lower hare density in 2008-2015 (0.8 – 1.0 hares/ha [0.3 – 0.4 hares/ac]; Harrison *et al*. 2016, entire). This decline occurred across all forest stand types and across a broad geographic area of Maine (Scott 2009, p. 36; Harrison *et al*. 2016, entire), and a decline in hare density also occurred in the adjacent Gaspe region of southern Quebec (Assells *et al.* 2007 *in* Scott 2009, p. 41-42). Hares remained at these lower densities through 2015 (Harrison *et al*. 2016, p. 55). If future hare populations remain low, then Maine habitats will likely have a lower capacity for supporting resident lynx. How current and likely future hare densities in this unit compare to densities under historical disturbance patterns is unknown.

The habitat projections above also do not consider the effects of future spruce budworm outbreaks. After low levels of infestation for the last 20 years, Maine appears poised for another spruce budworm outbreak. Budworm numbers are increasing toward epidemic levels in southern Quebec and northern New Brunswick.Significant defoliation could occur in Maine in the next few years, and the outbreak may last about a decade (Wagner *et al.* 2015; pp. 12-16). Although research has clearly demonstrated that landowner response to the last outbreak resulted in unintended benefits for lynx from 1 to 3 decades later, our ability to project what effects the next outbreak will have on lynx habitat is limited because land ownership has changed since the last outbreak. To reduce risk from spruce budworm, some financial investment owners may cut younger spruce-fir stands that still support elevated hare densities. Some may be less inclined to intensively manage for spruce-fir and may switch to an emphasis on northern hardwoods. It is unlikely that current landowners will broadly apply pesticides to control spruce budworm or herbicides to promote spruce-fir regeneration after stands are defoliated. The MFPA may constrain clearcutting of infested stands, even with recently-enacted changes intended to reduce the regulatory burden for landowners. Despite these uncertainties, landowner response to the pending budworm outbreak will likely have important implications for the short- and long-term persistence of lynx habitat in northern Maine (Simons-Legaard 2016, pp. 16-17).

Climate Change – Because this geographic unit generally lacks potential elevational refugia (Carroll 2007, p. 1102; Siren *in* Lynx SSA Team 2016a, pp. 15 and experts, p. 37), its lynx population may be more vulnerable to deteriorating snow conditions than populations in the more topographically diverse western units, and changes in snow conditions could further restrict lynx distribution (Hoving 2001, pp. 27-28; Hoving *et al.* 2005, p. 749; Carroll 2007,

entire). This unit's only potential elevational refugia under reduced snow scenarios are in the mountains of western Maine, where favorable snow conditions may only persist as very small, isolated "sky islands" that would be unlikely to support lynx. Carroll (2007, entire) modeled the Maine lynx population assuming non-cycling hare populations and snow conditions expected under intermediate to high emissions climate models (Kiehl and Gent 2004, entire). He predicted a 59 percent decline in the lynx population (the non-cycling hare population model) by mid-century because of climate change alone, with larger declines projected from interactions between climate change and other factors (potential increased trapping in Canada and lynx population cycling; Carroll 2007, p. 1100). Wildlife experts in Maine ranked lynx as highly vulnerable to climate change (> 66 percent loss in species range/population and extirpation within 50 to 100 years; Whitman *et al.* 2013, pp. 19, 74).

Climate change is already affecting the Northeast, and the rate of change is faster than expected, with large changes observed since 1970 (Rustad *et al.* 2012 p. 6). Rapid winter warming in recent decades is believed to be exacerbated by an albedo feedback caused by the diminished persistence of snow in winter (Hayhoe *et al.* 2006, p. 25). Average winter temperatures are increasing about 0.4°C/decade (0.8°F/decade) with the greatest warming occurring in the coldest winter months (January-February; Burakowski *et al.* 2008, p. 1). Northeast climate models predict average winter temperature increases of 2.0°C (3.6°F; low emission) to 2.9°C (5.2°F; high emission) by mid-century and 3.1°C (5.6°F; low emissions) to 5.3°C (9.5°F; high emissions) by late century (Notaro *et al.* 2014, p. 6529). The largest increases in temperature are expected in northern Maine (Siren *in* Lynx SSA Team 2016a, Appendix 3; Rawlins *et al.* 2012, p. 9) where temperatures may increase 2.5° to 2.8°C (4.5° to 5.0°F) by 2050 (Fernandez *et al.* 2015, p. 3). In response to climate change, interest in wind development has grown in northern and western Maine, which has the potential to impact high-elevation habitats and potential spruce-fir refugia (Publicover 2013, p. 2).

Gonzalez *et al.* (2007, pp. 12-13 and 15-18) modeled distribution of boreal forest and future snow conditions under 9 different low, medium, and high emission scenarios and predicted reduced probablility of suitable snow (from 95 percent during 1961-1990, to 90 percent predicted for 2071-2100) and very minor changes in forest cover type in Maine by the end of the century. Although there are uncertainties about future climate warming, if projections are accurate, the area capable of supporting resident lynx in Maine could be expected to recede northward and lynx populations to decline substantially in this unit over the next 100 years (Vashon *et al.* (2012, p. 60). If future trends in increasing temperature and decreasing snow occur as projected, then at some time in the future lynx would be unlikely to persist in Maine.

Snow Duration - The current average snow duration in Maine is at or below the 4-month snow persistence threshold believed necessary to support lynx (section 4.2.1; Gonzalez *et al.* 2007, p. 7). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005, p. 15) and is expected to diminish by another 2 weeks in Maine by mid-century (Fernandez *et al.* 2015, p. 10). It is projected to decline by 25 percent (low emissions) to 50 percent (high emissions) from current conditions by the end of the century (Hayhoe *et al.* 2006, pp. 21-25). Similarly,

Notaro *et al.* (2014, p. 6543) projected an average decrease of 28 days (low emission) to 47 days of snow cover (high emissions) by the end of the century.

Snow Depth - The current average annual snowfall in northern Maine is at or below the 270-cm/yr. (106-in/yr) threshold below which lynx are unlikely to occur (Hoving *et al.* 2005, p. 749; section 4.2.1), and it is expected to decline in the future with projected continued climate warming. From 1965-2005, Northeast winter snowfall has decreased by about 4.6 cm/decade (1.8 in/decade), with the greatest decreases occurring in December and February (Burakowski *et al*. 2008, p. 1). By the end of the century, large areas of the Northeast will experience 15-percent (under a low-emissions scenario) to 25-percent (high-emissions scenario) reductions in snowfall (Ning and Bradley 2015, p. 6). Similarly, Notaro *et al.* (2014, p. 6529) concluded that average snowfall in the northeastern United States and southeastern Canada will decline by 59 cm (23 in; 31 percent) under a low-emissions scenario) to 92 cm (36 in; 48 percent) under a high-emissions scenario by the end of the century because a higher proportion of winter precipitation is projected to fall as rain rather than snow. Hayhoe *et al*. 2006, (pp. 22-25) predicted that under moderate and high climate scenarios there would be large reductions in the length of the snow season with < 25-50 percent reductions in the number of snow days by 2070-2099.

Snow Quality - Winter precipitation in Maine is projected to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006, p. 28) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, entire; Hayhoe *et al.* 2006, p. 23; Ning and Bradley 2015, entire). Snow density and compaction (caused by wet, heavy snow or rain on snow events in winter) will likely continue to increase in the region in the future (Karl *et al.* 1993, entire; Dudley and Hodgkins 2002, pp. 8-10, 19-20; Huntington *et al.* 2004, p. 2632; Huntington 2005, entire; Hodgkins and Dudley 2006, entire).

Loss of Boreal Forest - The boreal spruce-fir forest type has come and gone from New England during the post-glacial period. It nearly disappeared from the Northeast during the interglacial warming period 1000 years ago, then moved south into New England only in the past few centuries during the “Little Ice Age” (Schauffler and Jacobson 2002, entire; DeHayes *et al.* 2000, entire). Continued anthropogenic climate warming is projected to cause another northward contraction of spruce-fir forest in the Northeast with potential negative consequences for both lynx and snowshoe hares (Gonzalez *et al.* 2007, entire). Because of its sensitivity to climate and its mobile nature, the spruce-fir forest type in the Northeast, including northern Maine, is projected to decline substantially in response to climate change even under low-emissions scenarios and could disappear completely under higher-emissions scenarios (Iverson and Prasad 2001, pp. 192-193; Prasad *et al.* 2007, entire; Beckage *et al.* 2008, entire; Iverson *et al.* 2008, p. 403; Ollinger *et al.* 2008, p. 17; Jacobson *et al.* 2009, p. 27; Tang and Beckage 2010, entire; Whitman *et al.* 2010, p. 12; Andrews 2016, p. 20). Even under the lowest emissions scenarios, spruce-fir forest would be reduced by the end of the century (Williams and Liebhold 1997, pp. 210-214; Prasad *et al.* 2007, entire; Mohan *et al*. 2009, pp. 221-222), although some spruce-fir may persist at the highest elevations (Tang and Beckage 2010, pp. 148-156) and along the eastern coast (Jacobson *et al.* 2009, pp. 26-29) where cooler conditions

would likely persist. Climate change is anticipated to increasingly fragment the boreal forest in northern New England (Iverson *et al.* 2008, pp. 400-405), which would diminish the amount and quality of lynx habitat (Simons 2009, pp. 221-222). Recent shifts of northern hardwoods to higher elevations formerly occupied by boreal forests have also been attributed to regional warming over the last century (Beckage *et al*. 2008, entire).

Spruce (red, black, and white) and balsam fir are the most important boreal forest conifer tree species in the Northeast and will be affected by climate change in different ways. Mechanisms of injury to spruce-fir include winter injury from freeze-thaw cycles, spring drought (because of reduced snowpack), and reduced seed germination (Auclair *et al.* 2010, pp. 694-695). Thus, the range of spruce-fir is limited by summer heat and drought. Mohan *et al.* (2009) projected that the suitable area for balsam fir would be 80 percent lower by 2100 under an average- to high-emissions scenario. In contrast, Ollinger *et al.* (2008, p. 8) projected increasing growth rates for balsam fir and red spruce to mid-century, after which they would decline. Andrews 2016 (p. 53, 104) modeled future climate envelopes for spruce and fir species in Maine under a moderate emissions scenario and predicted northward shifts in these species. The results suggest that areas of suitable climate for these tree species would diminish in northern New England by 2030, white and black spruce would disappear from northern Maine by 2060, and balsam fir and red spruce would dwindle to only a few high altitude locations by 2060. However, suitable habitat for spruce and fir species would remain in northern and coastal highlands of New Brunswick and Cape Breton Island Nova Scotia.

The timescale of the spruce-fir decline in the Northeast is difficult to predict because of the many variables that influence shifting of the forest species composition (emissions scenarios, the long lifespan and slow dispersal rates of trees, frequency of disturbance, competition from advancing hardwoods and invasive tree species, complex interactions with moisture, and synergistic effects with other pollutants). Support for an accelerated decline includes evidence that spruce-fir is already in decline and is being replaced in Maine by northern hardwoods (oak, pine, red maple). Since 1995, the area of forest land classified as the northern hardwoods type in Maine has increased 8.9 percent (by about 2,400 km^2 [927 mi^2]) and the area in the spruce-fir forest type group has decreased 8.5 percent (1,987 km^2 [767 mi^2]; McCaskill *et al*. 2016, p. 2). Although forest disturbance often favors northern hardwoods, it may, in some situations, favor balsam fir and help it persist longer in a warming climate (Scheller and Mladenoff 2005, p. 318). A pending spruce budworm outbreak and frequent disturbance from forest management could accelerate conversion to northern hardwoods. Other climate-related forest disturbances (forest pests, diseases) could further accelerate conversion to northern hardwoods (Iverson *et al.* 2008, p. 404).

In contrast, some authors note that trees migrate slowly in response to a changing climate and are long-lived. Therefore, a time lag may occur in shifting forest composition from spruce-fir to northern hardwoods (Mohan *et al.* 2009, p. 221; Zhu *et al.* 2012, pp. 1048-1051). Some northern Maine industrial forest landowners could “adapt” to climate change by intentionally favoring spruce-fir (e.g., by plantations and use of herbicides).

Finally, there is uncertainty concerning the influence of climate change on balsam fir, a short-lived, shade-tolerant conifer that dominates much of the understory in the Acadian forest and is an important component of lynx habitat in the Northern Maine Unit. McWilliams *et al.* 2005 (p. 8) noted that balsam fir increased in Maine's forest inventory in the early 2000s because this species seems to respond favorably to frequent disturbance. Forest models projected increases in spruce-fir biomass over the next century because of partial harvesting and periodic budworm outbreaks, but did not take climate change into consideration (Simons-Legaard *et al.* 2013, entire). In contrast, Iverson *et al*. 2008 (p. 400) identified balsam fir as the tree species in Maine most sensitive to a warming climate, and they projected large declines, with only 29 percent (low emissions) to 16 percent (high emissions) persisting by the end of the century. Climate change will influence precipitation and temperature, forest management strategies, and forest disturbance (fire frequency and spruce budworm), all of which will interact in complex ways to influence balsam fir at the southern edge of its range. Carter (1996, pp. 1092-1093), Iverson *et al.* (1999, pp. 400, 403), and Goldblum and Rigg (2005, p. 2714) documented balsam fir growth rates and growth potential would decline under likely climate warming scenarios (about a 2.2°-2.8°C (4°-5°F) temperature increase by the end of the century and reduced snow conditions). Some have projected the extirpation of spruce-fir forest types in the Great Lakes States (Scheller and Mladenoff 2005, entire) and New England (Iverson *et al*. 2008, entire. 403). Balsam fir has prolific seed production following forest disturbance such as harvesting (Seymour 1992, p. 217), and has proliferated under the current climate and forest management regime dominated by partial harvesting (Olson *et al.* 2013, entire). Balsam fir is a relatively short-lived tree (about100 years), and is unlikely to persist long if climate change affects seed and germinations rates. Given anticipated climate changes, especially early snow melt and low spring precipitation, fir may increase for the next few decades but is unlikely to regenerate in the future Maine forest (Simons-Legaard 2015, *pers. comm.*).

Vegetation Management - Habitat suitable for lynx is expected to decline in the future (see Regulatory Mechanisms section above). By 2020, all of the extensive areas that were clearcut in the 1970s and 1980s will be greater than 35 years of age and no longer likely to support high hare densities. For the foreseeable future, partial harvesting will continue as the primary means of forest management. Although partially harvested forests with well-developed understory structure may provide foraging opportunities via increased prey access (Fuller *et al.* 2007, 1984-1985), snowshoe hare densities are approximately 50 percent less in landscapes dominated by partially harvested stands (Robinson 2006, pp. 5-37; Fuller and Harrison 2010, p. 1276). Thus changing forest management practices have and will continue to reduce landscape hare density possibly below levels that can support lynx.

Sources of uncertainty concerning future habitat conditions in northern Maine include changes in forest policy, timber harvesting methods, changing timberland ownership, response to budworm outbreaks, and timber markets - all of which have occurred in the recent past and will undoubtedly shape forest management in the future (Simons-Legaard *et al.* 2016, p. 8). Currently, the landscape is owned primarily by financial investors who may be less inclined to intensively manage for spruce and fir after the next outbreak of the spruce budworm (Wagner *et al.* 2015, p. 4).

The dramatic shift from clearcutting to partial harvesting presents a challenge for lynx conservation in this unit for the next several decades (Legaard *et al*. 2015, p. 21). Lynx habitat is expected to peak and then remain stable through about 2012-2020 and then decline (Simons 2009, pp. 153-165, 202-220; Simons-Legaard *et al.* 2016, p. 6). After 2020, aging of the former clearcuts and extensive partial harvesting are projected to result in a 50 to 65 percent decline in lynx habitat by 2032 (Simons 2009, p. 217). Lynx habitat will decline from about 9.5 percent of the landscape (current condition) to about 5.0 percent of the landscape (Simons-Legaard 2016, fig. 8, p. 10). By 2032, the Northern Maine Unit may support less than half the number of resident lynx that it does today (Simons 2009, pp. 209, 217).

In the future, lynx habitat is projected to become fragmented into smaller, isolated parcels and shift southward into areas currently occupied by bobcats and fishers, where snow conditions are unlikely to favor lynx occupancy (Simons 2009, pp. 153-165; Simons-Legaard *et al.* 2016, pp. 1, 6; Simons-Legaard 2016, p. 8). By 2022, the number of patches of high-quality hare habitat is modeled to increase by 57 percent, but the average size of patches would decline by 87 percent and patches would become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6). The proximity index of high-quality habitat patches is expected decline by 78 percent within lynx home ranges. Although lynx habitat in this geographic unit is currently peaking, fragmentation may diminish its future ability to support as many resident lynx as it does currently (Simons-Legaard *et al.* 2016, p. 8).

Beyond 2030, assumptions concerning future climate change, land ownership, and harvest rates introduce greater uncertainty. The most optimistic forest management models (greatest harvest rates, no climate change, no spruce budworm) project that lynx habitat will likely decline over the next few decades then gradually increase to about 10 percent of the landscape by 2060 (Simons-Legaard 2016, fig. 8, p. 9). Other models (lowest harvest rates, no climate change, no spruce budworm) project about 5 percent of northern Maine will likely have high-quality hare habitat from 2030 to 2060 (Simons-Legaard 2016, fig. 8, p. 9), although the habitat will be much more fragmented and patch sizes will be smaller (Simons-Legaard *et al.* 2016, entire).This could represent a return to conditions similar to those that occurred historically prior to the landscape-scale clearcutting the created the current condition, perhaps resulting in commensurate changes in Maine'slynx population.

A shift toward managing private timberlands as softwood plantations could offset losses in spruce-fir and become a form of adaptation to climate change effects of reducing spruce-fir forest types. Jack pine plantations are extensive in adjacent New Brunswick (Etheridge *et al.* 2005, p. 1966). A forest company that has planted extensive spruce plantations in New Brunswick recently purchased nearly 4,047 km^2 (1,563 mi^2) of forestland in northern Maine where it is doing the same. Spruce plantations are becoming more common on this ownership in Maine, but not on others. Stand structure and intensive management of plantations are highly variable (e.g., pruning, thinning, herbicide treatments), thus hare densities and use by lynx vary (Roy *et al.* 2010, entire). Hares can achieve higher densities in plantations depending on the amount of lateral (horizontal) cover, but for shorter periods of time; about 10 to 17 years after

cutting and planting in New Brunswick (Parker 1984, p. 163) and 15 to 25 years in Quebec (Roy *et al.* 2010, p. 585). This is in contrast to about 15 to 35 years in naturally regenerating spruce-fir stands after harvest (Simons-Legaard *et al.* 2016, p. 4). The future of plantations in the northern Maine unit is uncertain. Most investment landowners have short-term investment horizons and are unlikely to invest in plantations.

Natural stand-replacing disturbances in this unit are rare and infrequent and, other than spruce budworm outbreaks, are unlikely to significantly affect future habitat conditions (Hoving *et al.* 2004, p. 292). At its peak in 1975, budworm affected nearly all of Maine's 8 million acres of spruce and fir with greatest mortality (up to 49 percent) of balsam fir and less for the spruce species (Livingston 1998, pp. 26-27). A very large outbreak has thus far defoliated 60,700 km^2 (over 23,000 mi^2) of spruce-fir in southern Quebec, immediately north of Maine (Wagner *et al.* 2015, pp. 2-3), and it is projected to expand into northern Maine in 2018-2021, potentially putting much of Maine's 23,472 km^2 (9,063 mi^2) of spruce-fir stands across the State at risk of defoliation. However, despite the severe defoliation of spruce-fir forests in southern Quebec, some project a weaker outbreak in Maine because spruce and fir trees are younger and less susceptible and there is a higher hardwood component in northern Maine forests (Wagner *et al.* 2015, p. 18-22). A typical outbreak lasts for a decade.

Forest management strategies for addressing the coming budworm outbreak vary and include applying insecticides (although land area sprayed is expected to be small compared to the previous outbreak), pre-emptively cutting mature spruce-fir before defoliation, stopping precommercial and commercial thinning, and salvaging dead and diseased trees (Wagner *et al.* 2015, pp. 38-48). The nature and aggressiveness of forest management response to budworm outbreaks could greatly affect future outcomes for lynx habitat (see section 4.2.1). The next budworm outbreak and subsequent forestry response is a disturbance agent that may accelerate changes in forest composition influenced by climate change, especially toward increased northern hardwood and reduced spruce-fir. The nature of land ownership is greatly changed from the 1970s and 1980s, and landowner response is expected to be diverse depending on their objectives and investment horizons. The pending budworm outbreak cast additional uncertainty on the status of lynx habitat in this geographic unit beyond 2030.

Climate change, forest management and budworm outbreaks will interact to influence the future trajectory of spruce-fir forest in Maine. All 3 variables have yet to be modeled simultaneously (Legaard 2016, *pers. comm*.). Assuming current forest management trends persist to the end of the century, spruce-fir dominated forest is expected to continue to decline (Legaard *et al.* 2013, entire). The combination of budworm-induced mortality and salvage harvesting will have a negative effect on spruce-fir (Legaard *et al.* 2013, entire). However, after a budworm outbreak the biomass and area of mixed-hardwood/softwood forest would be expected to increase through this century primarily because of the proliferation of regenerating balsam fir (see discussion above; Legaard *et al.* 2013). Mixed forests having a high (greater than 50 percent) hardwood component are not believed to support high hare densities (Scott 2009, p. 109) or to be preferred by lynx (Vashon *et al.* 2008b, pp. 1492-1493). It is uncertain whether lynx can adapt to lower landscape hare densities associated with mixed hardwood-softwood forest. They

may persist, but at lower densities as they currently do in the western units of the DPS. However, the probability of persistence is further diminished by deteriorating snow conditions and potentially increased populations of bobcats and other competitors.

Wildland Fire Management - Susceptibility of the northern Maine unit to fire may be enhanced by a severe spruce budworm outbreak because of the amount of dead and dying spruce-fir (Stocks 1987, entire), although there were no large fires after the last outbreak. Fire risk is currently very low in this unit and a continuous decrease in fire frequency is predicted with climate change in eastern Canada because of increased precipitation and decreased drought (Bergeron and Flannigan 1995, entire; Flannigan *et al.* 1998, entire). Climate is expected to become more variable (i.e, wider extremes of summer drought and precipitation) during the next century (Gregory & Mitchell 1995, entire; Gregory *et al.* 1997, pp. 684-685), which could create fire conditions in unusually dry years (Flannigan *et al.* 1998, p. 475). Maine's policy is to immediately suppress wildfire, thus large, stand-replacing fires are expected to be infrequent in this region in the future. Notable large fires in Maine include a 1.2 million-ha (3 million-ac) fire in 1825 and an 81,000 ha (200,000-ac) fire in 1947.

Habitat Fragmentation - The future of the 40,470-km^2 (15,630-mi^2), sparsely populated "North Woods" of Maine is highly uncertain and has been the subject of intense public debate (Baldwin *et al.* 2007, entire). Land use and zoning in the state's "unorganized townships" are the responsibility of the Land Use Planning Commission (LUPC) in the Maine Department of Conservation. The LUPC revised its Comprehensive Land Use Plan (Maine Land Use Regulation Commission 2010, entire), and described principal values in guiding future land management decisions: maintaining working forests, provide for traditional recreational opportunities, protect high-value natural resources, and encourage long-term conservation. The North Woods has long been considered a public resource or "commons," even though privately owned (Judd 2007, p. 9). This land was traditionally owned by a few large timber companies, but since the 1980s there has been turnover in ownership largely by investments companies and subdivision of large parcels (Hagan *et al.* 2005, entire). Financial investors, primarily Real Estate Investment Trusts (REITS) and Timber Investment Management Organizations (TIMOs), focus on maximizing the asset value of timberlands and are increasingly likely to seek revenue from non-timber resources if they generate a higher return. These new owners operate over relatively short (5- to 15-year) time horizons and are willing to consider multiple means of monetizing their asset, including development and real estate sales (Legaard *et al*. 2013, entire). If left unchecked, these pressures may continue to promote dispersed development throughout this region. Parcelization and subdivision has increased, particularly in the southern third of the jurisdiction (Maine Department of Conservation 2010, p. 72-73). The LUPC has limited ability to address stressors on Maine's North Woods, including resale and subdivision trend. This trend is likely to continue into the foreseeable future and will make management of large, forested landscapes for lynx even more difficult.

Historically, development has stayed mostly on the edges of the North Woods jurisdiction with the exception of scattered seasonal dwellings and sporting camps in the interior, but this could change in the future. Between 1971 and 2005, the LUPC permitted 8,136 new dwellings in

unorganized townships, increasing the number of residences by 66 percent during this time period (Maine Land Use Regulation Commission 2010, p.80). Between 1971 and 2005, the LUPC also issued 1,353 development permits for new uses scattered throughout the unorganized townships (Maine Land Use Regulation Commission 2010, pp. 97-99), with most (42 percent) being recreational facilities (boat launches, campsites, gatehouses, recreational lodges). Most development has occurred in areas that abut organized communities and near public roads. Within the interior, most development has occurred along lakeshores and other waterfront. However, the amount of hillside and ridge development is growing and this trend is likely to continue (Maine Land Use Regulation Commission 2010, p. 136), which will likely further fragment lynx habitat.

We have an incomplete understanding of the effects of outdoor recreation on lynx and their habitat (ILBT 2013, p. 80). Future trends in outdoor recreation in northern Maine are also uncertain (Vail 2007, entire). A portion of the North Maine Woods is a gated road system that encompasses about 1.4 million ha (3.5 million ac). Visitation by outdoor recreationists is currently about 175,000 per year and declining. Likewise, visitors to Baxter State Park and the Allagash Wilderness Waterway have declined (Vail 2007, p. 107). Aside from a vigorous discussion of the recently-designated Katahdin Woods and Waters National Monument or a master tourism plan for the area (Vail 2007, pp. 112-113), there could be stagnant or declining participation in traditional outdoor recreational activities in the future (Vail 2007, p. 107). Alternately, increased numbers of second homes and resorts could increase visitor numbers in the future. Snowmobiling may be an exception and has risen in popularity in northern Maine, but it too may decline because of declining snow (see section 3.2). The effects of new or expanded downhill ski development on fragmentation of lynx habitat are expected to be minimal. Future trends in outdoor recreation and associated effects on lynx, hares, and their habitat in northern Maine are uncertain.

Within the last 5 years, 2 landowners developed concept plans for rezoning for large-scale development of hundreds of house lots and resort development within designated lynx critical habitat. Under one concept plan, 975 houses and 2 resorts would be constructed on about 14 km^2 (5.5 mi^2) and a 1,469-km^2 (567-mi^2) conservation easement would be established. A second concept plan would allow development on about 8 km^2 (3 mi^2) of land and establishment of a 59-km^2 (23-mi^2) conservation easement. Although these developments have not been built, they may portend future trends in land use.

Energy production is emerging as a potentially significant economic factor in this unit, with the potential for grid-scale industrial wind and solar power, biomass, biofuels, and other energy sources. Wind energy resources are high within the lynx critical habitat (National Renewable Energy Laboratory 2010[25]), and wind development in the lynx critical habitat are likely to accelerate in the foreseeable future. Two large wind energy projects are being considered in designated lynx critical habitat in this unit; if built, each would cover about 450-650 km^2 (180-250 mi^2) and become 2 of the largest such projects in Maine. Mining is not a traditional land use

[25] http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mecitation; last accessed 5.25.2016.

in this unit, but a large mining operation is being considered within designated lynx critical habitat. Extraction operations for gravel (for road building) are widely-scattered throughout the unit.

The area designated as lynx critical habitat is heavily-roaded, particularly with forestry roads. While accurate numbers are difficult to obtain, approximately 1,500 miles of public roads and over 20,000 miles of private roads exist within unorganized areas of Maine (Maine Department of Conservation 2010). There has been discussion of an east-west limited access highway through northern Maine and extending Interstate 95 north from Houlton to Presque Isle, which, if constructed, would further fragment habitat (Maine Department of Transportation 1999; Beck *et al.* 2012, p. 38).

An increasing area of the designated lynx critical habitat in this unit is likely to be placed under conservation easements that will limit future development and fragmentation of lynx habitat. Maine has the largest amount of land under easement of any state, and there are about 8,094 km^2 (3,125 mi^2) of conservation easements in lynx habitat in northern Maine (Pidot 2011). Continued expansion of areas under conservation easement is uncertain and will depend on willing landowners and funding available for purchase of easements. Conservation easements often include abandonment of some development rights, but they may allow for wind power development and other land uses that may not be compatible with lynx conservation. Easements in Maine allow forest management, but they rarely prescribe specific management that would benefit lynx and other species of conservation concern. If market conditions continue, trends toward forest certification will likely continue in Maine for the foreseeable future. Currently, 8 million acres are enrolled in Maine by SFI and FSC (Wagner et al. 2016, p. 31). Certification has the potential to address lynx management in the future.

The Core Team believes that all development trends portend increased loss and fragmentation of lynx habitat in the Northern Maine Unit. As habitat is lost and fragmented as a result of development and forest maturation and management, it will become increasingly difficult to influence landscape-scale forest management that could benefit lynx. However, whether (and if so, when) future development may result in population-level impacts to lynx in this unit is uncertain.

Conclusion

After reviewing the scientific literature concerning snow and climate change and acknowledging other potential stresssors unique to this unit (e.g., lack of forest planning for lynx, land ownership turnover, and development pressures), the Core Team believes that lynx habitat and numbers in Maine will diminish substantially in the future. We believe the number of resident lynx in Maine is at an historically (unnaturally) high level and will likely decrease over the next several decades, perhaps to levels more like natural historical conditions, and perhaps (but with increasing uncertainty) to even lower numbers in the more distant future (end of this century). Given current trends (diminishing snow conditions, extensive partial harvesting and fragmentation of spruce-fir forest, possible pelage mismatch for hares, increasing populations of

bobcat and fishers in a lower-snow environment),we believe landscape level hare densities are likely to decline in northern Maine. Extended periods of lower hare numbers would likely reduce the number of lynx and the probability that this unit would continue to support a persistent resident lynx population in the future.

We concur with expert assessments concerning trends in forest management, but we also note that development pressures in northern Maine did not receive much discussion at our expert elicitation workshop. We believe development pressures (residential and commercial development, energy development, transmission lines, roads, mining) may increasingly become competing land uses on private lands in northern Maine. We also expect continued turnover and subdivision of private forest lands in northern Maine, which could accelerate opportunities for non-forestry land uses. Turnover in land ownership has provided opportunities to conserve some areas of the North Maine Woods through purchase of conservation easements and fee title acquisitions, including a new Katahdin Woods and Waters National Monument. However, conservation easements do not fully protect these lands from some kinds of development that could adversely affect lynx and their habitat. For example, many conservation easements allow large-scale, industrial wind power development. We conclude that various forms of development in northern Maine will continue in the future.

The Core Team believeslynx in Maine would be more exposed to potential adverse impacts in a future scenario without Federal listing. The lynx is not State-listed in Maine but it is considered a species of special concern. There is rarely a nexus for Service review of forestry projects under section 7 of the ESA (i.e., no Federal funding or permits are typically required for forest management on private lands). Nevertheless, because of its Federal listing, the Canada lynx are a priority species for planning by Federal, Tribal, State, and private forest landowners. Although few private landowners have thus far made formal commitments to intentionally manage their forests for lynx, by virtue of their Federal listing status they at least consider the possibility of doing so in the future. This is particularly true of landowners who must plan for Federal listed species as a requirement of their enrollment in green certification programs. Without Federal listing, there would be no incentive or motivation for private forest landowners to change the current paradigm of partial harvesting and intentionally engage in forest management to benefit lynx. With current Federal listing, there is a nexus for the Service to review other projects in northern Maine (e.g., Army Corps of Engineers permits for wetland impacts); for new highways, transmission lines, large-scale energy development, mining, and residential and commercial development. Without Federal listing, few of these projects would consider lynx. Critical habitat has been an important consideration in the Federal review of the aforementioned kinds of development projects. Critical habitat also has had a positive influence on land conservation in northern Maine, with land trusts and non-governmental organizations using the lynx and their critical habitat as justification for seeking funds for conservation easements. This justification for habitat protection would no longer be valid if the DPS was not Federally-listed. The Core Team concludes that a future scenario without Federal listing would result in increased habitat loss and fragmentation and would result in reduced justification for habitat protection initiatives in northern Maine.

Lynx would be at greater risk without ESA section 9 prohibitions against take. There is currently a closed season on lynx, but it is uncertain whether legal trapping of lynx would resume in Maine if the DPS was not listed. If the DPS was not listed, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished. If the DPS was not listed, Maine's incidental take permit for trapping would not apply, and it is possible that some protective measures to minimize injury, take, and mortality of lynx could be diminished. Habitat mitigation for lethal take of lynx associated with the Maine trapping HCP also would cease. About 10 lynx have been illegally shot and reported or otherwise discovered since listing. Illegal shooting and non-reporting could increase without Federal protection. We believe several high-profile Federal law enforcement cases have helped to reduce illegal shooting of lynx.

After considering the lynx expert's opinions and the best available scientific information, the Core Team is less optimistic than the experts regarding the long-term (end-of-century) persistence of resident lynx in this unit. All potential stressorss – forest management, climate change, habitat loss and fragmentation, and development – are increasing in frequency, intensity, and extent. The amount of high-quality hare and lynx habitat created by clearcutting in the 1970s and 1980s recently peaked at unprecedented high levels that are unlikely to be achieved again. Because of state law, forest management has shifted dramatically away from clearcutting to many forms of partial harvesting, which on average support less than half the hare densities of regenerating clearcuts. Forest land ownership has, and continues to change, further subdividing private forest lands. Furthermore, hare densities have declined by half and have remained at these lower levels. Lynx habitat in the next few decades will shift south to areas that will be more influenced by climate change and northward range expansion by bobcats. Thus, we conclude that the carrying capacity to support lynx is diminishing, and the lynx population will decline as the quantity and quality of boreal forest habitat declines. There are few commitments by private forest landowners to manage specifically for lynx conservation.

After reviewing the best available scientific information, we believe that climate change will be a significant stressor to lynx in the Maine unit; perhaps more so than expressed by experts. Unlike other units, as snow condition decline there is little potential for elevational refugia for lynx in Maine. Spruce-fir is being replaced by northern hardwoods because of climate change. Frequent forest cutting and disturbance, including a pending spruce budworm outbreak, could accelerate conversion to northern hardwoods. We acknowledge that the rate of spruce-fir decline is uncertain, but note that some of the science reviewed indicates the spruce-fir forest type could nearly disappear from Maine by late-century under both low and high emissions scenarios. Climate change models portend declining snow conditions from low- to high-emissions. Because increases in temperature are thus far tracking high emissions scenarios we are less optimistic for snow conditions that favor lynx by mid- to late-century. In the past decade, interest in development has increased in lynx critical habitat, especially proposals for large-scale residential and resort development and extensive wind energy development that could cover hundreds of square miles. We conclude that these stressors, individually and cumulatively,

indicate diminished populations of lynx and their habitat. If these stressors are not abated, we believe that the probability of persistence will be lower by mid-century and that lynx will have a greater likelihood of extirpation by the end of the century than projected by experts.

5.2.2 Unit 2 - Northeastern Minnesota

Expert Projections of Lynx Persistence

The experts that we consulted indicated an initially high and subsequently declining probability of persistence of resident lynx in Minnesota, with increasing uncertainty through the end of the century (Lynx SSA Team 2016a, pp. 37-38). Near term drivers of the projected decline were climate-driven reduction in snow quality, quantity, and persistence; potential increased competition from bobcats; and forest insects. Long term drivers were climate-driven loss of spruce-fir forests; further reductions in snow quality, quantity, and persistence; potential competition from bobcats; and potential increases in wildfire activity.

Climate change was primarily associated with loss of boreal forest but also could potentially increase disease or insect outbreaks, and is likely to affect the amount of precipitation falling as good quality snow in the area of the state supporting lynx habitat. We heard varying prognoses from experts on the speed at which climate-induced loss of boreal forest will occur. The scientific literature suggests (and 1 of the climate change experts indicated) that loss of spruce-fir could occur relatively quickly in the Midwest and Northeast (but possibly more slowly elsewhere in the DPS because of potential elevational refugia), and all noted that an increase in northern hardwood composition of the forest is already occurring. Connectivity to lynx in Ontario reduces the likelihood of local extirpation in this geographic unit, but the likelihood would increase if connectivity was to become compromised in the future if habitat recedes northward and becomes increasingly fragmented on both sides of the border, as expected with continued climate warming.

Despite uncertainty, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of boreal forest, and potentially increased bobcat competition and hybridization are likely to reduce the probability of lynx persistence in this unit. Experts expressed uncertainty about the likelihood and severity of future insect outbreaks (and how this could affect future lynx habitat) and the potential introduction and spread of diseases.

Taking all of these factors into consideration, experts provided “most likely” persistence probabilities of 88 to 100 percent (median = 96 percent) in the near-term (year 2025), 60 to 90 percent (median = 80 percent) at mid-century, and 10 to 60 percent (median = 35 percent) at the end of the century (fig. 11). As they did for most other geographic units, all experts indicated an initially high and subsequently decreasing likelihood that resident lynx will persist in this unit, with uncertainty increasing substantially over time.

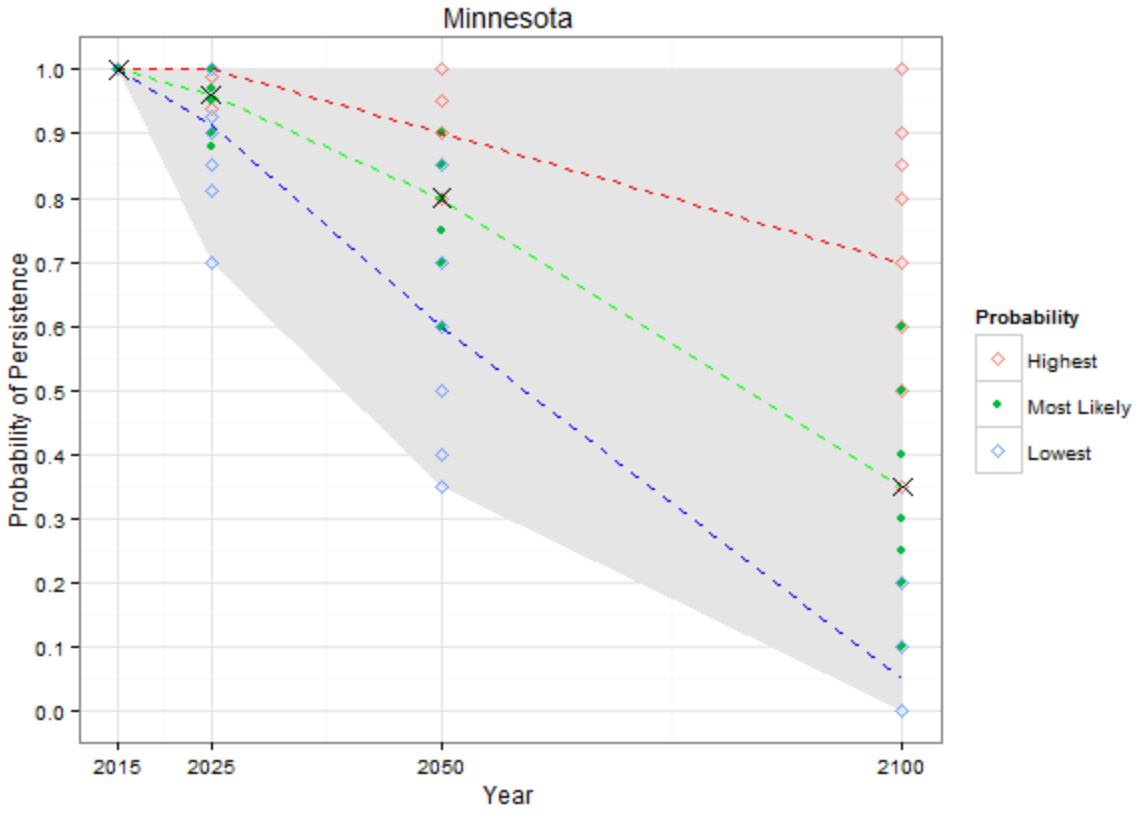


Figure 11. Lynx expert estimates of the probability that the Northeastern Minnesota Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - In Minnesota, the vast majority of lynx habitat that supports a long-term persistent lynx breeding population is administered by the SNF. This area includes designated critical habitat (79 FR 54782). The SNF consults with the FWS to consider the effects of any projects on lynx and its critical habitat and is anticipated to do so as long as the species is listed under the ESA. The SNF is currently implementing the 2004 SNF Plan (USFS 2004a, entire), which has direction based on the LCAS (Ruediger et al. 2000, entire) and the Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (USFS and USFWS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can maintain, restore, or create lynx habitat, and the SNF has a long-term commitment to doing so. If the SNF continues to follow vegetation and wildland fire management and other applicable recommendations in accordance with the LCAS (including consideration of new scientific information as it becomes available) in its Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. Management of lynx and its habitat on SNF land will remain in place until the forest amends or revises its LRMP. We expect that management

direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on National Forest System lands will be incorporated into the revised or amended Forest Plans (LRMPs). Although management of lynx habitat and lynx conservation efforts on the SNF could change in the future if the DPS was not listed, the species would be placed on the Regional Forester's Sensitive Species list for a minimum of 5 years, which gives it a higher priority than other species for monitoring and management during that time.

The Chippewa and the Chequamegon-Nicolet National Forests occur outside the Northeastern Minnesota geographic unit and the area considered to be core lynx habitat (i.e., where lynx are persistent and are reproducing). However, because lynx occasionally occur on these forests, the Forest Plans for both also include direction based on the LCAS and the CA between the Forest Service and the Service for all forest activities that occur within LAUs (USFS 2004b, entire; USFS 2004c, entire). These 2 forests consult with the FWS to consider the effects of any projects on lynx and are anticipated to do so as long as the species is listed under the ESA. It is unclear if lynx habitat management and conservation efforts on these national forests would change if the DPS was not listed in the future.

Additionally, the Minnesota Department of Natural Resources (MNDNR) manages approximately 36 percent of the lynx habitat in this unit, and privately-owned lands make up about 16 percent of the unit. Under the Sustainable Forest Resource Act of 1995 (revised in 2014), the Minnesota Forest Resources Council (MNFRC) has developed guidelines for site-level timber harvesting and forest management (MNFRC 2013, entire; MNFRC 2014, entire). These voluntary guidelines are intended for private and State landowners and include some general recommendations for wildlife but are not specific to lynx (MNFRC 2014, pp. 4-5). It is expected that the MNFRC guidelines will remain in place into the future and that voluntary actions will continue. Private landowners, however, do not have an official commitment to land management. We cannot say with any certainty what proportion of privately owned land will follow those guidelines into the future, because following the guidelines is voluntary. The MNFRC guidelines are less comprehensive and are not specific to lynx, and therefore may not be as beneficial to lynx and lynx habitat as the lynx and hare specific direction followed by the Forests.

The NPS manages Voyageurs National Park, which is also within the Minnesota unit. Voyageurs National Park protects an area of 882 km^2, of which 534 km^2 (62 percent) is covered by forests and other uplands (Moen *et al.* 2012, p. 348), but does not have lynx specific direction in its management plan (NPS 2002, entire). The National Park consults with the FWS to consider the effects of any projects to lynx (NPS 2002, p. 26) and is anticipated to do so as long as the species is listed under the ESA. Lynx documented on and near Voyageurs National Park are probably transient animals (Moen *et al.* 2012, p. 348).

Approximately 1 percent of the Minnesota unit is managed by the Grand Portage Band of Chippewa, which has been actively working on lynx conservation since 2004. Timber sales and harvest practices on the reservation follow an integrated plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management

practices benefit snowshoe hares (Deschampe 2008, entire) and are expected to continue into the future.

In response to a 2008 court ruling, the MNDNR drafted a plan (currently under review by the Service) to minimize the likelihood that lynx would be incidentally trapped during otherwise legal trapping of other furbearers in Minnesota. As described above in section 3.1.2, the MNDNR designated a Lynx Management Zone (LMZ) where it enforces special trapping regulations to minimize the incidental take of lynx (MNDNR 2016a, pp. 53-55). In 2015, the MNDNR als issued emergency trapping rules in the LMZ mandating additional restrictions on the types of traps that may be used (MNDNR 2015, entire) to further reduce the likelihood of incidental take. If the DPS was not listed, we expect that the State would continue efforts to reduce incidental trapping of lynx. Although we consider it unlikely, it is possible that State-managed trapping of lynx could resume in the future if the DPS was not listed.If that were to occur, we assume the State would proceed only after demonstrating the level of harvest the population could sustain and carefully developing, enforcing, and monitoring a strict trapping quota system to ensure that harvest level would not be exceeded.

Climate Change - The direct and indirect effects of climate warming are expected to affect lynx in Minnesota (Siren *in* Lynx SSA Team 2016a, pp. 15 and Moen *in* Lynx SSA Team 2016a, p. 19) and could restrict their future range. As described in section 3.2, new information on regional climate change and potential effects to lynx habitat that has become availalbe since the DPS was listed suggests that lynx distribution and habitat is likely to shift northward in latitude and upward in elevation within its currently occupied range as temperatures increase. Because of its generally flat topography, this geographic unit presents little opportunity for elevational migration of lynx and lynx habitat. Other protential impacts of climate change include (1) diminishing snow depth, quality, and duration, perhaps resulting in increased competition from bobcats, coyotes, and other terrestrial hare predators and increased hybridization with bobcat, (2) conversion of spruce-fir to northern hardwoods, and (3) potential future isolation of resident lynx in this unit because of diminishing forest conditions in southern Ontario.

Gonzalez *et al.* (2007, pp. 8, 12-19) predicted the persistence of boreal forest and historical (1961-1990) snow suitability for lynx (95 percent historical and future probability of suitable snow) in this unit through 2071-2100, and suggested that the SNF could provide a potential refugium for lynx. Notaro *et al.* (2015, pp. 1668-1669) projected changes in lake effect snowfall using downscaled climate models (Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4; Elguindi *et al.* 2011 and Giorgi *et al.* 2012 as cited in Notaro *et al.* 2015) for the Great Lakes Basin. Siren (*in* Lynx SSA Team 2016a, p. 15) stated that climate models show an increase in lake effect snow in the eastern Great Lakes until 2050, with a decline later in the century, with an overall decline in the amount and duration of snowpack in the Midwest.

Historical lynx records occurred in areas with at least 4 months (120 days) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). In northern Minnesota from 1959-1979, the number of days with snow cover ≥ 2.5 cm (1 in) ranged from 130 to 160 days; ≥ 15 cm (6 in), from 85 to

130 days; ≥ 30 cm (12 in), from 50 to 100 days; and ≥ 61 cm (24 in), from 10 to 30 days (Kuehnast *et al.* 1982, pp. 7-9). In the future, Notaro *et al.* (2015, p. 1675) projected a general reduction in the frequency of heavy lake-effect snowstorms during the twenty-first century, with the exception of projected mid-century increases around Lake Superior when local air temperatures are expected to remain low enough for precipitation to fall largely in the form of snow. The snow season in the Great Lakes basin is likely to become substantially compressed during the twenty-first century with dramatic increases in rainfall (Notaro *et al.* 2015, pp. 1676-1678). The Minnesota unit may be more vulnerable to snowpack loss due to lack of elevational refugia (Siren *in* Lynx SSA Team 2016a, p. 15).

Normal annual snowfall from 1981-2010 in northeastern Minnesota ranged from 140 to 241 cm/yr (55 to 95 in/yr)[26] and is projected to decline across the Great Lakes Basin in the future (Notaro *et al.* 2015, p. 1675). Snow conditions favorable for lynx (depth, consistency, and persistence) are projected to deteriorate in the Great Lakes Region. Notaro *et al.* (2015, pp. 1671-1674) projected a dramatic decline of Great Lakes ice cover that will become confined to the northern shallow lakeshores during mid-to-late winter by the end of the century. Ultimately, this leads to increased rainfall, not snowfall, as these projected reductions in ice cover and greater dynamically induced wind fetch lead to enhanced lake evaporation and total lake-effect precipitation (Notaro *et al.* 2015, pp. 1674-1678).

Climate change is projected to cause some northward contraction of boreal conifer forest in Minnesota (Gonzalez *et al.* 2007, p. 16, 18), with some potential loss of habitat at the southern portion of lynx habitat in the State but persistence of boreal forest in this geographic unit (Gonzalez *et al.* p. 2007, p. 19). Gonzalez *et al.* (2007, pp. 8, 13) also projected that northeastern Minnesota, including the SNF, would continue to have snow conditions suitable for lynx at the end of the century, and may serve as a refugium for lynx in the Lower 48 States. However, Moen (*in* Lynx SSA Team 2016a, p. 19) questioned this result, noting that the Gonzalez *et al*. model predicted a much larger distribution of suitable snow conditions than the area currently occupied by lynx in Minnesota. Moen presented preliminary snow modeling results that project snow conditions suitable for lynx could shrink significantly by 2055, be limited to extreme northeastern Minnesota by 2070, and could be entirely absent from the state by 2095 (Moen and Catton *in* Lynx SSA Team 2016a, p. 19). Frelich (*in* Lynx SSA 2016, p. 14), concluded that Minnesota could lose the boreal biome completely, possibly within the next 60 to 70 years, with unmitigated climate change. Similarly, Galatowitsch *et al*. (2009, pp. 2015-2016) concluded that the boreal forest of the Northern Superior Uplands (which encompass this geographic unit) will likely be lost by 2069 as a result of warmer summers and more frequent and longer droughts associated with climate change. If a refugium for lynx does persist in this unit in the future, it would likely only consist of the small area in Cook County (the extreme northeastern corner of the unit) with slightly higher elevations (518-701 m [1,700-2,300 ft) than the majority of the area that is now considered lynx core habitat and would, therefore, support a much smaller number of resident lynx than likely occur in the unit now. Although uncertainties remain, as elsewhere, about the timing and magnitude of future climate-driven impacts, lynx

[26] http://www.dnr.state.mn.us/climate/summaries_and_publications/normals_snow_1981_2010.html; accessed 5.24.2016.

populations in Minnesota are expected to recede northward and decline over the next century (Lynx SSA Team 2016a, pp. 37-38).

Vegetation Management - Vegetation management similar to that conducted under current Forest Plans will likely continue into the future on Forest Service lands in Minnesota as long as the DPS is listed. These activities include timber harvest (thinning, clear-cutting, shelterwood, partial cut, and uneven-aged cutting); wildlife restoration projects that involve tree cutting, shearing, burning, seeding, and planting; prescribed burning for ecological purposes, hazardous fuel reduction, and site preparation; and mechanical site preparation. If the DPS is de-listed, the species would be placed on the Forest's Regional Forester Sensitive Species list for a minimum of 5 years, which gives it a higher priority than other species for monitoring and management during that time; however, it is unclear what the forest management would entail during or after that period of time.

Vegetation, timber, and minerals management authorized under current Forest Plans in Minnesota have the potential to adversely affect lynx and lynx critical habitat by reducing habitat quality for denning, foraging, and dispersal; disrupting travel, resting, and foraging patterns; disturbing denning females; and reducing habitat quality for lynx prey species, especially snowshoe hares. Depending on the timing, frequency, intensity, extent, amount, or other conditions, impacts may be variable among similar projects. Using the LCAS as a basis, the Forest Plans have incorporated a number of components that would reduce the risk of those impacts into the future. We expect that management direction for lynx addressing vegetation management on National Forest System lands in the future will be incorporated into revised or amended forest plans, using LCAS as a basis. Future Forest Plan revisions will likely maintain broad direction to design and implement vegetation management projects to maintain or restore conditions for lynx foraging and denning habitat and to maintain or improve juxtaposition of required habitat types and connectivity.

Over the long term, the Forest Plan will alter vegetation patterns on the landscape. Suitable hare habitat was predicted to decrease over time with implementation of the Forest Plan, but has actually increased since 2004 (USFWS 2011b, p. 51). Management activities that create unsuitable conditions for hare generally include clear-cut and seed tree harvest, and might include management-ignited fire, mechanical site preparation, salvage harvest, and shelterwood and commercially-thinned harvest, depending on unit size and remaining stand composition and structure. Suitable hare habitat is predicted to remain above the range of natural variation, which is essentially a description of conditions that existed prior to European settlement (1600 – 1900 A.D.) of the area (USFS 2004a, p. 105). Further, unsuitable habitat for lynx would vary only slightly with continued implementation of the Forest Plan and would remain distinctly below the maximum of 15 percent unsuitable in a decade prescribed in the LCAS and incorporated into the Forest Plan. Current (2010) unsuitable habitat levels are below what was predicted in the 2004 (USFWS 2011b, pp. 51-52). Because suitable habitat on National Forest System lands alone is such a high percentage within LAUs and the SNF is the majority landowner within most LAUs, we expect that in the future, the Forest would not approach the LCAS maximum of 30

percent of lynx habitat on all ownerships in an unsuitable condition within an LAU at any time, which would be ensured by corresponding guidance in the Forest Plan.

Wildland Fire Management - Unlike the Maine unit, the susceptibility of the Minnesota unit to fire may be reduced by periodic spruce budworm outbreaks. Measurable defoliation from spruce budworms has occurred in Northeastern Minnesota continuously since 1954 and is expected to continue into the future (Russell and Albers 2016, entire). Modeling to evaluate the relative strength of interactions between spruce budworm outbreaks and fire disturbances in the BWCAW showed that budworm disturbance can partially mitigate long-term future fire risk by periodically reducing live ladder fuel within the forest types of the BWCAW but will do little to reverse the compositional trends caused in part by reduced fire rotations there (Sturtevant *et al.* 2012, pp. 1286-1292). The SNF manages for wildfires through preventative measures such as fuels reductions, but does not manage for wildfires in the BWCAW. Natural successional changes and those associated with natural phenomena, such as wildfire or windstorms, are the dominant force in BWCAW ecosystems and are expected to continue to be in the future.

Habitat Fragmentation - Ravenscroft *et al.* (2010, p. 329) considers northeastern Minnesota forest landscape as largely unfragmented. The BWCAW remains intact and contiguous with Canada. Within the SNF, natural disturbances and vegetation management activities make up most of the annual human-caused fragmentation in actively managed portions of the Forest. These areas typically re-vegetate within 3 to 5 years, depending on the forest type and number and type of activities (USFS 2011a, p. 119). The SNF's Forest Plan (USFS 2004a, Appendix E) provides direction on limiting lynx habitat fragmentation and the Forest actively consolidates habitat through land acquisitions and exchanges. The Forest direction limiting habitat fragmentation is expected to continue as long as the DPS is listed.

Fragmentation, Development, and Human Access - Throughout the SNF and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Still, much of the land within the Forest remains undeveloped and lynx habitat remains relatively intact and well connected. This is particularly true on the SNF, which has a "high standard" road density of roughly 0.45 mi/mi^2 outside the BWCAW.

Human access to lynx habitat occurs by foot and motorized vehicle, including recreational and off-road motor vehicles (RMVs and ORVs), and generally occurs on trails, low standard roads, and temporary roads developed for management operations, particularly timber harvests, and more recently, minerals exploration. While open, these roads provide access to lynx habitat. As northern Minnesota has become more developed and the human population has increased, the SNF has sustained increased visitation in recent years (USFS 2011a, p. 5) which increases the opportunity for human-lynx encounters, especially by trappers. Lynx are likely to continue to be incidentally trapped at the current rate as a result of continued access via low standard roads and trails on the Forest. Any corridor open to RMVs provides the potential for Forest visitors to incidentally trap, shoot, or collide with lynx. Temporary road construction for minerals

exploration projects may contibute significantly to temporary road densities and increase human access during the time the roads are being used. Temporary roads in mineral exploration projects may stay open longer (1-15 years) than those predicted by the Forest Plan EIS for resource management (1-5 years). If these sites are left accessible to the public, then human-lynx conflicts may increase. Additionally, intersections of new roads, closed temporary roads and/or roads open to the public are likely to become parking areas for cars, which would indirectly increase public access. Further, these corridors could increase potential competition through increased snow compaction. Effective road closures, however, may reduce the potential effects to lynx and their habitat.

Energy and Mineral Development - Mining (e.g., iron ore and taconite mining) is occurring at several locations in or near the lynx core habitat area in northeastern Minnesota (MNDNR 2016c, entire). Large-scale mining operations on non-Forest land could result in irreversible or irretrievable loss of lynx and hare habitat. Minerals exploration has increased and is occurring at many locations in northeastern Minnesota, which may lead to more large-scale mining projects. Vegetation clearing for minerals exploration projects may have temporary impacts to lynx and hare habitat at drill pad sites, although impacts from pad sites are expected to be minimal and temporary because the foot print of individual drill pads is typically small and the cleared land is expected to re-vegetate. Drill pad site preparation includes vegetation clearing on small patches of land (average of approximately 0.6 ha [1.6 ac]). This cleared land may provide snowshoe hare habitat after it has time to revegetate. Mineral exploration activities use existing Forest roads but also may require construction of new roads and may potentially add a significant number of road miles. Land exchanges associated with proposed mining sites could result in a loss of lynx and hare habitat under Forest management, but may also result in consolidation or gain of habitat with newly acquired lands (*e.g*, the Forest may able to consolidate lands that they can then manage for lynx). Stone quarry extraction operations are also scattered throughout the unit (MNDNR 2016c, entire) and may impact lynx and hare habitats.

Conclusion

We concur with the expert panel that this unit is very likely to continue to support resident lynx in the near-term (2025) and mid-term (2050). However, after reviewing the scientific literature concerning climate change projections (diminishing snow conditions, northward contraction of boreal forest, lack of elevational refugia, potential for increased competition, disease, and insect outbreaks), some Core Team members were less optimistic about the future of lynx in Minnesota than the lynx expert panel. Depending on future emissions levels, the likelihood that this unit will continue to support resident lynx at the end of the century may be lower than the 35 percent (median most likely) estimate based on expert opinion. The threat for which the lynx was listed, lack of specific conservation direction, associated regulations, and lynx forest management planning has not been addressed on private lands in Minnesota, except through voluntary guidance. There is some uncertainty about the future of forest management and future development on private forest lands in Minnesota and in adjacent lands in Ontario, although there are some basic voluntary management guidelines for private lands in Minnesota. Further, if the DPS is de-listed, there is uncertainty whether the lynx direction on Forest lands would

continue into the future. It is projected that habitat will diminish and recede northward over the mid- to longer-term because of continued climate warming. Hybridization and competition with bobcat also may increase with diminishing snow conditions because of continued climate warming, and it is uncertaint how insect outbreaks or disease may affect habitat and lynx in this unit.

The Core Team believes the Minnesota lynx populations would be expected to decline more rapidly in a future scenario without Federal listing. The lynx is designated as a species of special concern (MNDNR 2013, p. 2), a less restrictive designation than state threatened or endangered. There is a closed season on lynx, and it is expected that intentional take would continue to be prohibited until the population reached sustainable levels defined by the state. In Minnesota, the large proportion of lynx core area owned by the Forest Service provides a nexus for USFWS review of Forest projects under section 7 of the Endangered Species Act (i.e., there is rarely federal funding spent on forestry and no federal permits required for forest management on private lands), which would be lost post de-listing. Because of their Federal listing, Canada lynx are recognized as a priority species for planning by Federal, Tribal, State, and private forest landowners. Voluntary guidelines that consider the Federal listing status may guide private landowners to consider measures to help conserve listed species in the future. Without Federal listing driving voluntary conservation guidelines, however, there could be reduced incentive for some private forest landowners to intentionally engage in forest management to benefit lynx. With current Federal listing, there is a nexus for the USFWS to review other projects in northeastern Minnesota (e.g., Army Corps of Engineers permits for wetland impacts) for new highways, transmission lines, large-scale energy development, mining, and residential and commercial development. Without Federal-listing, the agencies funding or permitting these projects would not be required to consider impacts to lynx and designated critical habitat. The Core Team concludes that a future scenario without Federal listing would likely result in increased habitat loss and fragmentation and reduced incentive for habitat protection initiatives in northeastern Minnesota.

Lynx would be at greater risk without Endangered Species Act section 9 prohibitions against take. In a future scenario without Federal listing, Minnesota's incidental take planning effort for trapping would become moot, likely resulting in diminished protective measures to minimize injury, take, and mortality of lynx. Even with these prohibitions and protections, incidental trapping of 16 lynx has been reported in Minnesota since listing, resulting in at least 6 mortalities. It is uncertain if lynx would become a legally trapped furbearer in Minnesota if the DPS was not listed (although a legal wolf hunt was reinstated after that species was delisted in Minnesota, so regulated trapping could also be considered for lynx if the DPS was not listed). Seven lynx have been illegally shot and reported or otherwise discovered since listing. Illegal shooting and non-reporting could increase without Federal protection. Education efforts by Federal and State agencies and law enforcement agents may have helped to reduce illegal shooting of lynx in this unit. With a diminished snow regime, populations of bobcats could increase and expand north and eastward into areas currently occupied by lynx. Incidental take of lynx from bobcat trapping and hunting activities would likely increase without Federal listing. Similarly, fisher, fox, and coyote populations may increase in a diminished snow regime in

northern Minnesota and trapping would be expected to occur there that could lead to greater incidental take of lynx. We believe that despite a closed hunting and trapping season, incidental take would continue and possibly increase and could become a significant stressor to a population of lynx that could be substantially diminished between mid- and late-century.

After considering the best available scientific information, including the opinions of lynx experts summarized above, the Core Team was less optimistic than the experts about the long-term (end-of-century and beyond) likelihood that resident lynx will persist in this geographic unit. All potential stressors –climate change, habitat loss and fragmentation, mining and development – are increasing in frequency, intensity, and extent. Lynx habitat in the next few decades will likely shift north to areas that will be more influenced by climate change and northward range expansion by bobcats. Thus, we conclude that this unit's ability to support resident lynx will likely diminish in the future, and the lynx population will likely decline as the quantity and quality of boreal forest habitat declines. Although there are voluntary forest management measures to consider listed species on private forest lands, there are no commitments by private forest landowners to manage specifically for lynx conservation. We also believe that climate change will be a significant stressor to lynx in this unit; slightly more so than expressed by most of the experts. Snow depth and duration in the area currently supporting resident lynx are projected to decline significantly by the end of the century, likely to the detriment of both hare and lynx populations. Unlike most other units, as snow condition decline there is little potential for elevational refugia for lynx in Minnesota except, perhaps, a small area of slightly higher elevation in the extreme northeastern corner of the unit. The boreal forest in this unit is already being replaced by northern hardwoods because of climate warming. Frequent forest cutting and disturbance, including a potential insect outbreak, could accelerate conversion to northern hardwoods. We acknowledge that the rate of boreal decline is uncertain, but note that some of the modeling we reviewed suggests that the spruce-fir forest type could nearly disappear from Minnesota by late-century under both low and high emissions scenarios. Climate models also portend declining snow conditions under low- and high-emissions scenarios. Because increases in temperature are thus far tracking high emissions scenarios, we are less optimistic for snow conditions that favor lynx by mid- to late-century. In the past decade, interest in development has increased in lynx critical habitat, especially proposals for large-scale mining developments. Although we expect resident lynx to persist in this unit through 2025 and 2050, we conclude that the stressors described above, individually and cumulatively, could diminish lynx habitat and numbers in this unit. If these stressors are not abated, we believe that resident lynx in this unit will face a slightly greater risk of extirpation by the end of the century than was predicted by lynx experts.

5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Expert Projections of Lynx Persistence

When considering the probability that this unit would continue to support resident lynx in the future, experts noted that despite projected losses of favorable forest and snow conditions, climate models project that some boreal forest will persist in this unit and that it will maintain

some areas of suitable snow into the future. Experts also noted that lynx in this unit primarily occupy public lands, which are actively managed for lynx into the future. Experts also considered recent and projected future increases in wildfire frequency, size, and intensity (Lynx SSA Team 2016a, pp. 41-43). Additionally, because of its connectivity to lynx populations and habitats in Canada, its large geographic extent, and the relatively large number and broad distribution of resident lynx it is thought to support, experts felt that future extirpation of lynx from this unit from either reduced genetic health or a catastrophic event is unlikely (Lynx SSA Team 2016a, pp. 25-34).

Overall, experts assigned a higher likelihood of persistence in this unit compared to the other geographic units. Most lynx habitats in this unit occur on Federal lands that are managed for lynx conservation, but 1 expert noted that little has been done to document whether lynx are responding to this management. The recent sale of large tracts of private commercial timberlands in the central part of this unit to The Nature Conservancy has increased protection for lynx via conservation easements managed for lynx. Habitats in some areas should improve in the near future as previously cut or burned areas mature into dense stands. Unlike the Maine and Minnesota geographic units (but similar to most other western units), high elevations in this unit could buffer the effects of climate change by providing for the upslope migration of lynx habitats and snow conditions that climate models predict. However, this would result in even patchier and more isolated islands of habitat in high elevation areas that would be more prone to extirpation from catastrophic or stochastic events. Competition from coyotes and bobcats seem to be less of a concern for this unit.

This unit has unimpeded connectivity with Canada, but some experts questioned whether this geographic unit depends on intermittent immigration of lynx from Canada, and whether the historical lynx population cycles in Canada believed to have fueled such immigration are still occurring or will into the future. There doesn't appear to be much demographic input from recent cycles. There is evidence of lynx from this unit moving north into Canada, but little evidence of demographic interactions among the 3 subpopulations (Purcell Mountains, Seeley Lake, and Garnet Mountains) in this unit. Experts noted that the Garnet Mountains subpopulation at the southern end of this unit may have recently become extirpated (a single lynx was later [February, 2016] confirmed by DNA analysis in this area, suggesting the potential for natural recolonization of this range, but no other lynx were documented during winter 2016/2017).

Discussion among experts indicated that fire was more of a concern for this unit. Increased fire extent and severity or other catastrophic events and small subpopulation effects in separated mountain ranges could affect lynx persistence in the future in some parts of this unit. Fire exclusion in this area for the last 100 years likely resulted in the accumulation of fuels; however, this unit may have a reduced probability of a catastrophic fire over time because of recent changes in management and recent fires that may have reduced fuels. Out to the year 2050 and beyond, some experts felt there may be more pressure on lynx populations in this unit from continued increases in fire extent and severity. Other experts expressed a different opinion of the overall effect of fire in this unit, indicating that it may actually improve habitat over time, and

that whether fires improve or degrade habitat depends on the frequency, intensity, size and spatial extent of future fires.

Experts discussed the possibility for increased precipitation and warmer temperatures in this unit because of climate change, and how this might affect lynx habitats. Boreal/subalpine forest may move up in elevation as described above; however, experts expected a shift in forest composition and diminished lynx habitat quality in the future with climate change. It is unknown how much the distribution of dry ponderosa pine (non-habitat for lynx) will increase with climate change, but it is likely to happen at some level. One expert cautioned that some climate modelers estimated that vegetation will lag about 50 years behind the projected changes in temperature and precipitation. Snow levels in lower elevation areas are already decreasing in some areas, which could lead to smaller areas for lynx to use in winter in the future.

Taking all of these factors into consideration, experts provided “most likely” persistence probabilities of 95 to 100 percent (median = 98 percent) in the near-term (year 2025), 70 to 100 percent (median = 90 percent) at mid-century, and 50 to 90 percent (median = 78 percent) at the end of the century (fig. 12). As they did for most other geographic units, all experts indicated an initially high and subsequently decreasing likelihood that resident lynx will persist in this unit, with uncertainty increasing substantially over time.

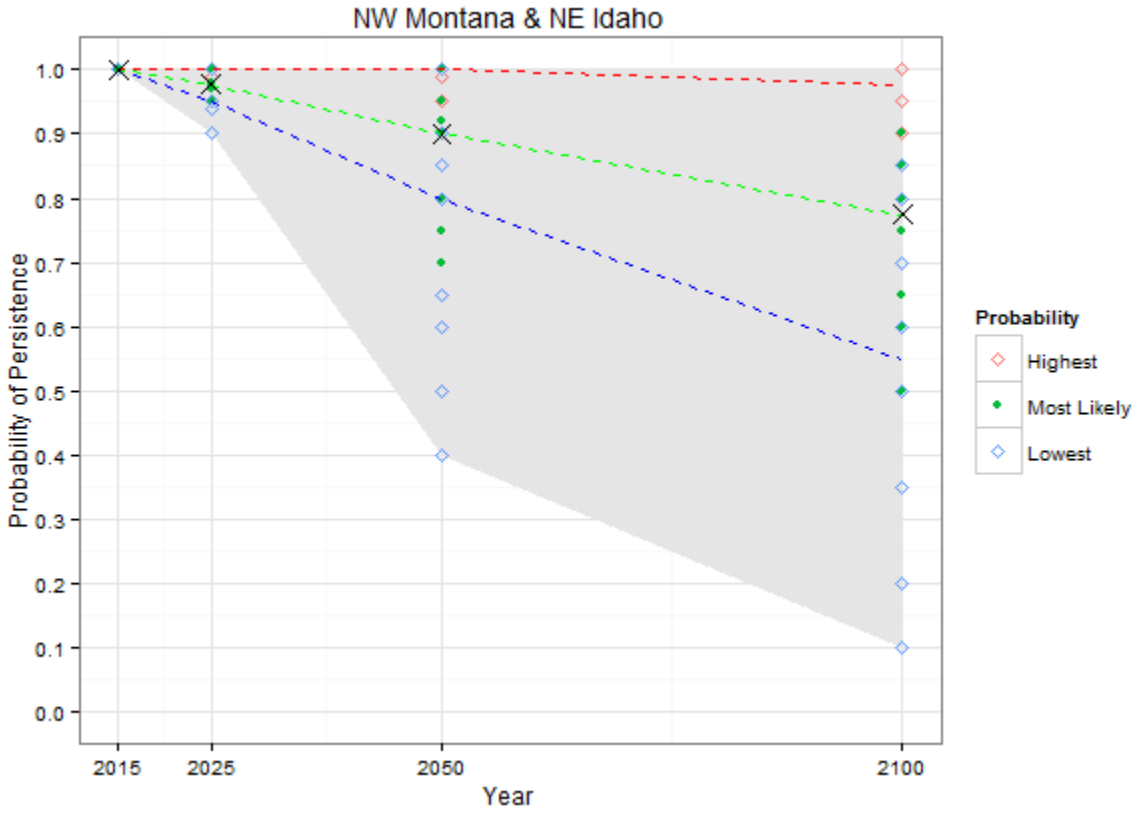


Figure 12. Lynx expert estimates of the probability that the Northwestern Montana/Northeastern Idaho Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - Federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Because most (84 percent) of this geographic unit consists of Federal lands, the regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations in this unit. When Forest Service, Park Service, and BLM management plans are revised or amended, they require opportunities for public participation in accordance with several statutes (e.g., the National Environmental Policy Act [NEPA], National Forest Management Act [NFMA], National Parks and Recreation Act, Federal Land Policy and Management Act [FLPMA]; USFWS 2014 pp. 26-34, also see 3.1). If plan amendments or revisions may affect listed species, management agencies must consult with the Service in accordance with section 7 of the ESA. If in the future the lynx DPS is determined by the Service to no longer warrant listing under the ESA (i.e., if the DPS is removed from the *Federal Lists of Endangered and Threatened Wildlife and Plants*), the ESA requires the Service, in cooperation with the States, to monitor the DPS for a minimum of 5 years to assess its ability to sustain itself without the ESA's protective measures. If, within the designated monitoring period, threats to the DPS change or unforeseen events affect its stability, then the DPS could be relisted or the monitoring period extended. Given these requirements, we expect that future Federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future Federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historical disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that Federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multi-story forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (BLM 2004a,

pp. 2-3; USFS 2007, Attachment 1, p. 2). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued Federal management designed to conserve or restore the capacity of the areas that historically or recently supported resident lynx populations, including the Northwestern Montana/Northeastern Idaho Geographic Unit, to continue to do so in the future.

On non-Federal lands (about 16 percent of this unit), as described above (sections 3.1.1 and 4.2.3, Habitat Status), recent acquisitions and conservation easements on some of the private lands in this unit will also reduce the likelihood of future adverse impacts to important lynx habitats. Similarly, the MTDNRC HCP includes a 50-year commitment to manage most (64 percent) State lands in this unit to conserve lynx foraging, denning, and connectivity habitats. Additionally, the Confederated Salish and Kootenai Tribe's objective to manage wildlife and habitats on the Flathead Reservation for future generations (section 3.1.2, Tribal Management) suggests continued management to conserve lynx habitats on Tribal lands.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will continue to support resident lynx into the future.

If the DPS was not listed, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2. Also, as noted above in section 4.2.3, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions of the snow conditions and boreal/subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016a, pp. 15-16; Siren *in* Lynx SSA Team 2016a, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016a, p. 15). In this unit, the probability of snow conditions comparable to those

associated with historical lynx occurrence records is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), although some parts of this unit are projected to retain favorable snow conditions (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016a, pp. 15, 41). Tennant *et al*. (2015, pp. 2818-2820) simulated snowpack loss in the Northern Rockies (ID, MT, WY) and predicted that watersheds between 1,000 - 2,000 m (3,281 – 6,562 ft) elevation would experienced the greatest snowpack losses, while those > 2000 m (6,562 ft) would be more resilient to significant warming. Given the greater predicted snowpack persistence at some elevations used by lynx in this unit and the considerable area of potential climate refugia in mountainous terrain (Dobrowski 2011, pp. 1027-1029; Curtis *et al*. 2014, entire; Holden *et al*. 2015, entire; Morelli *et al*. 2016, entire), at least a portion of lynx distribution in this unit is likely resilient to climate-driven losses in snowpack (IDFG 2017a, p. 7).

There will likely be a lag time between the loss of favorable snow conditions and an eventual shift or contraction in vegetative communities (Lynx SSA Team 2016a, pp. 43, 59; also see section 3.2), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely compromising this unit's future ability to support resident lynx populations.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, and to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on future lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of these landscapes to continue supporting resident lynx may be compromised, and lynx populations may be unable to persist until favorable vegetation conditions return. This is especially true where habitats and populations are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much if not all of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced (as is suspected) by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will likely reduce this geographic unit's ability to continue to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx populations in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of

historical and current lynx numbers and habitat distributions, preclude quantifying future habitat quality and distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will reduce future habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all Federal and most non-Federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and by encouraging the use of these activities to restore, improve, or create high-quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.3, past wildfire management, including fire suppression, does not appear to have altered the historical fire regime in lynx habitats in the western contiguous United States, including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current Federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.3, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although this increased wildfire activity does not appear to have diminished this unit's current ability to support resident lynx, it could do so in the future depending on the location, timing, and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support a resident lynx population until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many fires over a short time period could shift some parts of this unit from being just barely capable of supporting resident lynx to being incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity resulting from continued climate warming and drying, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.3, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation resulting from timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction of vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – As described above and in section 4.2.3, maintaining connectivity between this geographic unit and lynx populations in Canada is thought to be important, although it is uncertain if or to what degree immigration of lynx from Canada is essential to the persistence of lynx in this unit. A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2), which could alter the timing and magnitude of lynx immigration into the contiguous United States from Canada. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and a reduced probability of persistence among resident populations would be expected.

Although the extent to which this factor may influence lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016a, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. If this growth rate was applied continuously to a hypothetical resident population of 250 lynx (the midpoint of the range in the number of resident lynx this geographic unit may support based on expert opinion [Lynx SSA Team 2016a, p. 41]), the population would decline to 100 lynx after 11 years, about 50 lynx after 20 years, and roughly 20 individuals after 30 years. Vulnerability to demographic, environmental, and genetic stochasticity would increase as lynx numbers decreased, resulting eventually in an increased likelihood of functional extirpation of lynx from this unit (i.e., a lower

probability that the unit would continue to support a persistent resident lynx population). However, Schwartz (2017, p. 4) noted that very low immigration rates (less than 1 female/year on average for a theoretical population of 100 lynx) could provide population stability or even growth, suggesting that the Seeley Lake population and perhaps other DPS populations are probably being sustained by low levels of undetected immigration. Additionally, as noted above, the lynx population in the Purcell Mountains in the northwestern part of this unit was estimated to be increasing (λ = 1.16, 2003-2007; Squires *in* Lynx SSA Team 2016a, p. 20) over the last 4 years of the period for which the Seeley Lake population was estimated to be declining. In the absence of information on historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

Conclusion

After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is likely the most secure in the DPS. We conclude that it is very likely to continue to support resident lynx in the short term (through 2025) and through mid-century, although the number of lynx, the amount and distribution of high-quality habitat, and landscape-level hare densities are all likely to decline by mid-century as a result of continued climate warming and associated impacts. We also agree that this unit is more likely than not to support some resident lynx at the end of this century, although at that time we expect lynx numbers and distribution would be substantially reduced from the current condition and would, therefore, be more vulnerable to demographic, environmental, and genetic stochasticity and to catastrophic events, resulting in diminished resiliency. We acknowledge that under a *status quo* or increasing greenhouse gas emissions scenario the rate of climate-mediated loss, fragmentation, and isolation of habitat could, perhaps in concert with other factors (e.g., continued increases in wildfire size, frequency, and intensity and decrease in or complete loss of immigration from Canada), result in the functional extirpation of resident lynx from this unit before the end of the century. We also acknowledge, however, that there is great uncertainty with all persistence predictions that far into the future.

5.2.4 Unit 4 - North-central Washington

Expert Projections of Lynx Persistence

Compared to most other units, expert predicted a lower probability of persistence for this unit over the short term, and then a similar declining trajectory, with increasing uncertainty, by the end of the century, reflecting a more pessimistic outcome for this geographic unit than most other units (Lynx SSA Team 2016a, pp. 43-45). Experts felt that the probability of lynx persistence in this unit could decrease sharply over the next 10-20 years because of extensive recent fires in lynx habitats and the time needed for these areas to regenerate back to good hare/lynx habitat. However, 1 expert predicted an increase in persistence probability by mid-century as habitats impacted by recent large-scale fires regenerate into optimal hare-lynx

habitat. After that, the probability could rebound (or decline more slowly) over the longer term as these large areas return to prime habitat providing high hare densities.

Experts agreed that the current small population is likely at greater risk of extirpation because of stochastic events, particularly if large fires in lynx habitat continue to occur in the near future as they have in the recent past. A small population also could be more susceptible to disease, though no diseases have been documented among lynx in this unit. Experts discussed the extent to which small lynx populations could be reduced before they would become highly susceptible to stochastic demographic effects. It was suggested that 15-20 breeding individuals might be the minimum needed to avoid such susceptibility. Unimpeded connectivity between Canada and this unit could allow lynx to repopulate recently burned areas after the habitat recovers. Lynx in this unit are likely the southern portion of a larger population in Canada, not really a separate, isolated small population. Factors that influenced expert persistence probabilities for this unit included fire, habitat loss, and the future loss of favorable snow conditions predicted by climate change models.

Taking these factors into consideration, experts provided “most likely” persistence estimates of 60 to 95 percent (median = 80 percent) in the near-term (year 2025), 30 to 80 percent (median = 70 percent) at mid-century, and 5 to 50 percent (median = 38 percent) at the end of the century (fig. 13). Compared to most other geographic units, experts indicated greater uncertainty regarding short-and mid-term term persistence in this unit but, as for other units, uncertainty was greatest at the end of the century.

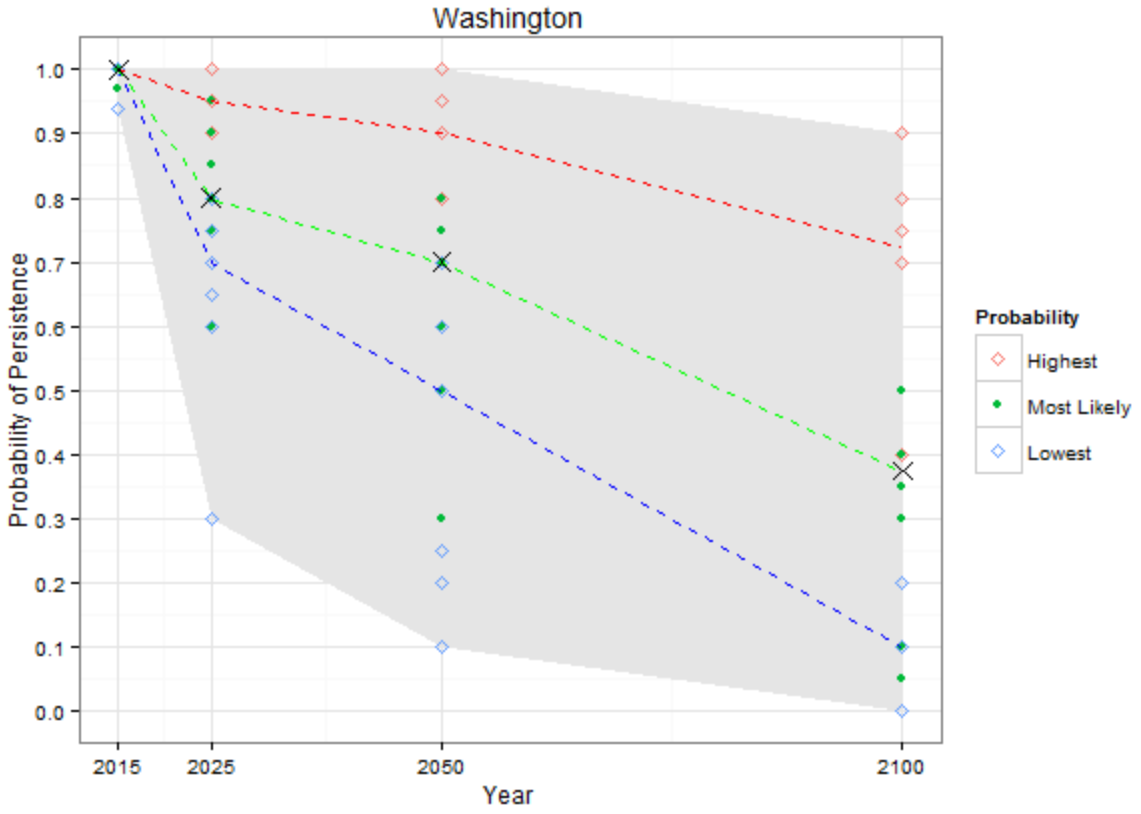


Figure 13. Lynx expert estimates of the probability that the North-central Washington Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - As described above (section 4.2.4), regulatory mechanisms currently in place guide forest management in this geographic unit for lynx conservation. We do not anticipate that existing regulatory protections for lynx would diminish appreciably in the future even if the DPS was no longer listed. On USFS lands, we anticipate that either the CA will remain in place (and/or be extended), or the OWNF and CNF will revise or amend their respective LRMPs to incorporate direction for lynx management similar to the formally amended LRMPs that have been implemented on all other national forests in the DPS range (see section 3.1.1). Currently, both the OWNF and CNF are in the process of amending or revising their LRMPs. We expect that management direction for lynx conservation addressing vegetation management, wildland fire management, and habitat fragmentation on National Forest System lands will be incorporated into the revised or amended LRMPs. We expect that both the OWNF and CNF will be required to manage for lynx and their habitat into the future because both forests will have incorporated lynx management direction into their respective LRMPs. We acknowledge that LRMPs can be amended or revised; however, LRMPS are typically in place for 15 years or longer, and the Service, other Federal and State agencies, and the public would have opportunities to comment on any proposed amendments or revisions to LRMPs through

the NEPA process. Therefore, we expect that both the OWNF and CNF will continue managing for lynx and their habitat into the future regardless of the DPS's listing status.

On State lands in this unit, the WADNR has committed to implementing its Lynx Habitat Management Plan until lynx are delisted or until 2076, whichever is shorter (WADNR 2006, p. 6). Additionally, the WADNR's internal policies encourage consideration of lynx habitat on lands it manages including participating in efforts to recover and restore endangered and threatened species, providing upland wildlife habitat, and establishing Riparian Management Zones. In accordance with legal obligations specified in the State's Forest Resource Plan, the WADNR will contribute to the future of Washington's lynx population by improving habitat conditions and reducing the likelihood of adverse effects on the habitat it manages (WADNR 2006, p. 6). Therefore, although some protections for lynx could be relaxed in the future if the DPS was not listed under the ESA, we anticipate that both Federal and State regulators would continue to manage for lynx conservation in this geographic unit.

Climate Change –Recent warming likely contributed to recent increases in wilfire activity in this unit and is likely to continue to do so in the future. Westerling *et al.* (2006, pp. 942-943) compiled information on large wildfires in the western United States from 1970-2004 and found that large wildfire activity has increased significantly from the mid-1980s with higher large-wildfire frequency, longer wildfire duration, and longer wildfire seasons. The greatest increases occurred in high elevation forest types including lodgepole pine and spruce fir in the northern Rockies (i.e., lynx habitat). They also found that fire exclusion (suppression) had little impact on natural fire regimes; rather, climate appeared to be the primary driver of increasing wildfire risk.

Koehler's (1990a, p. 847) estimated adult lynx density of 2.3 lynx/100 km^2 was obtained in an area supporting high-quality lynx habitat in the Meadows area of north central Washington (at least relative to other lynx habitat in Washington). Much of the lynx habitat in the Meadows was impacted by the recent large, stand replacing fires, resulting in further fragmentation of lynx habitat in the northern Cascades. Thus, the lynx densities Koehler observed in his study area may not be currently supported, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines.

As in other units, continued climate warming is projected to cause northward and upward shifts in spruce-fir habitats and snow conditions thought to favor lynx. In addition to potentially affecting fire return intervals, fire severity (intensity, size), and insect outbreaks, climate change is likely to affect the amount of precipitation falling as snow at elevations typically supporting lynx habitat in this geographic unit. Climate change is expected to impact the quantity, quality, and duration of snow in the Cascades. Mote (2003b, pp. 272, 274), who evaluated temperature trends in the Pacific Northwest using data collected by weather stations from 1930 to 1995, determined that the temperature increased in the Pacific Northwest and more precipitation fell in the spring and summer months, especially at elevations below 1,800 m (5,900 ft). Additionally, Mote (2003a, pp. 2-3) determined that an increasing temperature and precipitation trend from 1950 to 2000 is correlated with a 40 percent decrease in the snow water equivalent in the Cascades. Mote *et al.* (2005, p.45) determined that the Cascades are very sensitive to

temperature changes, with large increases in temperature potentially resulting in significant declines in snowpack. Corroborating Mote's results, Stoelinga *et al.* (2010, p. 2474) determined that the Cascade snowpack has declined by up to 40 percent in the latter half of the twentieth century, which resulted from increased temperatures. Furthermore, temperatures are predicted to continue increasing by 2° to 5°C (3.6° to 9°F) over the next century and are expected to cause further and accelerated losses in snowpack in the Cascades (Mote *et al.* 2005, p. 48). Continued declines of snowpack in the Cascades through 2025 are predicted to range from 9 percent (Stoelinga *et al.* 2010, p. 2486) to 29 percent (Elsner *et al.* 2010 *cited in* Stoelinga *et al.* 2010, p. 2486), which may also affect lynx densities supported in the Cascades.

Finally, some of the best lynx habitat in this geographic unit occurs on plateaus that may be more vulnerable to impacts of climate change because of the absence of higher elevation areas to which habitats and lynx could migrate in response to climate warming (Lynx SSA Team 2016a, p. 42). Thus, in addition to the recent losses of lynx habitat to large wildfires, coupled with increasing wildfire risk, the potential for the Cascades to support a viable lynx population may be further reduced because of projected climate-mediated decreases in snow quantity and quality. Overall, our review of the published literature on this subject leads the Core Team to conclude that climate change poses the greatest risk to the long-term persistence of lynx in this geographic unit.

Conclusion

After considering the best available scientific information and the opinions of lynx experts summarized above, the Core Team generally agrees with the experts that this geographic unit, like most others, has a relatively high likelihood of continuing to support a resident lynx population over the short-term (2025) and at mid-century (2050), but a lower probablility of doing so, with more uncertainty, by the end of the century (2100). As described above, the potential effects of climate change on the quantity and quality of snow, as well as the projected northward and upslope movement of spruce-fir and subalpine fir forests are likely to result in further fragmentation and reduction of lynx habitat within this geographic unit by the end of the century. More fragmented and smaller habitat patches are likely to support a smaller and more isolated lynx population that will be more vulnerable to stochastic environmental and demographic events. Over the past 25 years, wildfires have reduced lynx habitat in this geographic unit by almost 40 percent and likely reduced its carrying capacity for lynx by a similar amount. Additional future losses of lynx habitat resulting from climate-driven increases in wildfire size, frequency, and intensity may pose the greatest near-term threat to the persistence of this population. Connectivity between this unit and Canada is likely to remain intact in the future. Because lynx are highly mobile and able to traverse large areas of non-lynx habitat, we do not anticipate that climate change, in and of itself, will significantly affect connectivity between this geographic unit and the larger lynx population in southern British Columbia. This connectivity may contribute to maintaining a persistent, albeit smaller, lynx breeding population in this geographic unit into the future.

5.2.5 Unit 5 - Greater Yellowstone Area

Expert Projections of Lynx Persistence

Current and future factors expressed by experts as influencing probability of persistence for this unit included small population size, forest disease and insect pests, and fire (Lynx SSA Team 2016a, pp. 45-46). Some experts doubt that the GYA unit currently supports a resident breeding population of lynx. Experts indicated that climate models predict that some parts of the GYA unit could provide refugia from climate change impacts because of their high elevations and potential to maintain winter snow levels into the future. Summer conditions in this unit, however, could be drier in the future, resulting in increased fire frequency, extent, and intensity, and additional temporary habitat loss. However, regeneration of these areas and the extensive areas that have burned in the recent past may provide good habitat over the next several decades. Some experts suggested that lynx emigrating to this unit from Colorado could occupy such improved habitats in the near future. Colorado lynx have made exploratory movements into the GYA in summer months, and analysis of available data could improve our understanding of Colorado lynx movement into and use of the GYA. It is possible that lynx from Colorado could maintain lynx in GYA.

Taking these factors into consideration, experts provided “most likely” persistence estimates of 10 to 70 percent (median = 52 percent) in the near-term (year 2025), 15 to 60 percent (median = 35 percent) at mid-century, and 5 to 50 percent (median = 15 percent) at the end of the century (2100; fig. 14). Unlike other units, the expert graphs for this unit were widely variable and had high uncertainty at all time frames. This was the only unit for which most experts believed the current probability of persistence is low (i.e., that it is uncertain whether this area currently supports a resident lynx population). Some experts increased persistence likelihoods into mid-century based on the possibility that large areas impacted by the 1980s-era wildfires may by then regenerate into hare/lynx habitat, and on possible continued dispersal of lynx from Colorado into this unit. Unlike other units, where expert confidence in their predictions was initially high but decreased greatly beyond mid-century, expert uncertainty in this unit was high for all timpe periods and was related to uncertainty about whether resident lynx currently occur in the GYA.

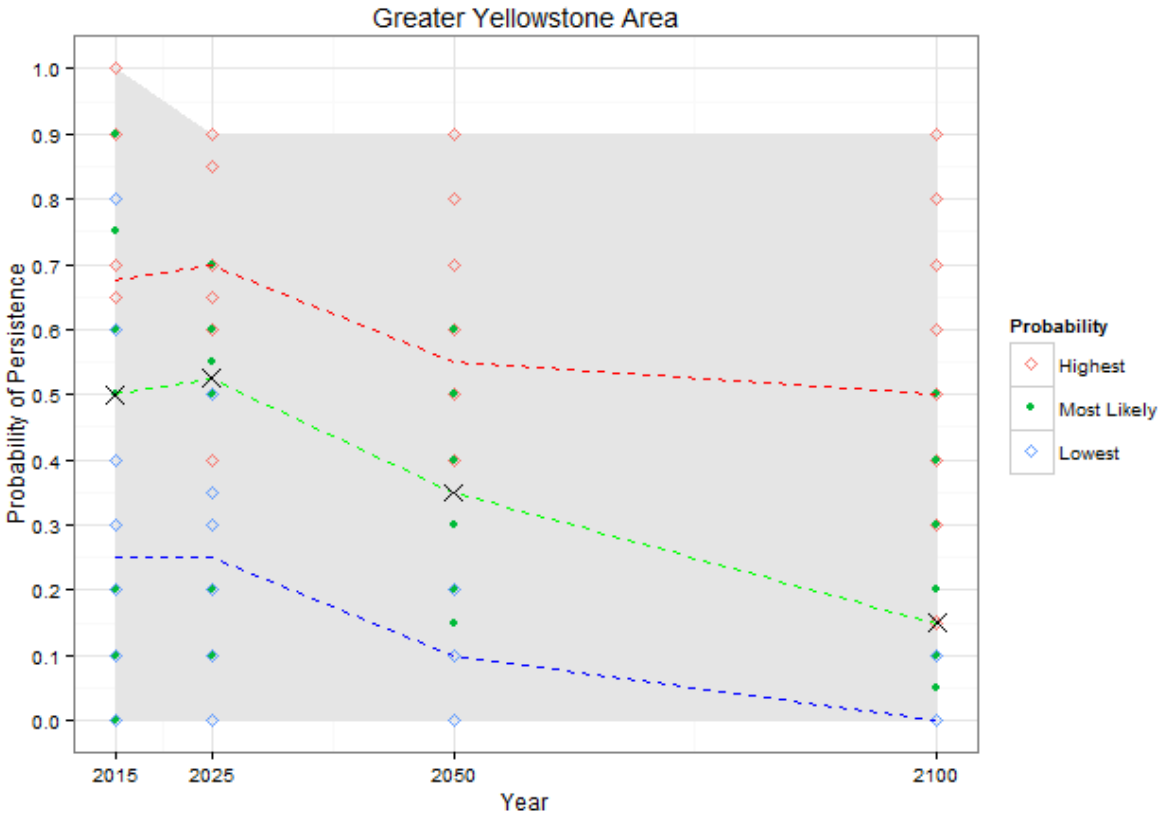


Figure 14. Lynx expert estimates of the probability that the Greater Yellowstone Area Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - As noted above in section 5.2.3, Federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Federal lands account for over 97 percent of this geographic unit; therefore, regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations. Also as described above, revisions or amendments to Federal management plans require opportunities for public participation in accordance with NEPA, NFMA, National Parks and Recreation Act, and FLPMA (USFWS 2014 pp. 26-34; also see 3.1) and consultation with the Service in accordance with section 7 of the ESA. If the DPS is delisted in the future, the ESA requires a minimum of 5 years of monitoring to assess its ability to sustain itself without the ESA's protective measures. If, during that time, threats to the DPS change or unforeseen events affect its stability, then the DPS could be relisted or the monitoring period extended. Given these requirements, we expect that future Federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future Federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historical disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that Federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multi-story forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (USFS 2007, Attachment 1, p. 2; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued Federal management designed to conserve or restore potential lynx habitats in this geographic unit in the future.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will support resident lynx into the future. Because non-Federal lands make up such a small proportion of this geographic unit, we believe it is unlikely that regulatory mechanisms on those lands will influence this unit's future ability to support resident lynx.

If the DPS was not listed, State-managed trapping could resume in this geographic unit, as elsewhere. We expect that would occur only if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2. Also, as noted above in section 4.2.5, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit.

Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal and subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016a, pp. 15-16; Siren *in* Lynx SSA Team 2016a, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016a, p. 15). In this unit, the probability of suitable snow conditions is projected to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016a, pp. 15, 46). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift or contraction in vegetative communities (Lynx SSA Team 2016a, pp. 43, 59; also see 3.2), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely further compromising this unit's ability to support resident lynx populations, which is already questionable.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, including the extensive fires in Yellowstone National Park in 1988, which burned over one-third of the park. Climate warming has also been linked to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of landscapes in the GYA to support resident lynx may be further compromised, and resident lynx may be unable to persist until favorable vegetation conditions return. This is especially true where potential habitats are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will likely further reduce this geographic unit's ability to support resident lynx into the future. The timing and

magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx and habitats in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historical and current lynx numbers and habitat distributions, preclude quantifying future habitat quality and distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will further reduce habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all Federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high-quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.5, past wildfire management, including fire suppression, does not appear to have altered the historical fire regime in lynx habitats in the western contiguous United States, including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current Federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.5, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although the extent to which increased wildfire activity has impacted this unit's current ability to support resident lynx is uncertain, such impacts may become more likely in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support resident lynx until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many fires over a short time period could cause a shift in some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity resulting from continued climate warming and drying, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the

potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.5, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation from timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – This geographic unit is not directly connected to lynx populations in Canada or elsewhere in the DPS range, although lynx released into Colorado have dispersed northward into and through this unit. There is no reliable evidence of intermittent immigration into this unit during past irruptions of lynx from Canada, as has been documented in other parts of the contiguous United States, although anecdotal occurrence reports (see section 2.3.2.2) may suggest a pulse of immigrants in the early 1970s during the second of 2 unprecendented irruptions. Nonetheless, as elsewhere in the DPS, immigration may influence the persistence of resident lynx in this unit. If continued climate warming or other factors further reduce the chances that dispersing lynx will reach this unit and contribute to its demographic and genetic health, either through habitat loss and fragmentation in potential dispersal corridors or declines in the amplitude of northern hare and lynx population cycles, the likelihood that the unit will support resident lynx in the future may also decline. However, as in Unit 3 above, because we lack information of historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

Conclusion

After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is the least secure in the DPS. We find that conditions for lynx in this unit are naturally marginal, its historical or current ability to support a persistent resident lynx population are questionable, and continued climate warming and associated impacts are likely to further diminish its already limited ability to support resident lynx. We conclude that it may continue to occasionally or intermittently support a small number of resident lynx and some reproduction over the short term (through 2025), but that it is very unlikely to support a persistent resident population over that time frame, even less likely that it will do so at mid-century (2050), and highly improbable that this geographic unit will support resident lynx by the end-of-century (2100).

5.2.6 Unit 6 - Western Colorado

Expert Projections of Lynx Persistence

Some experts indicated that beetle kill and fire could potentially create poor habitat conditions in large areas of this unit by mid-century, but that forest regeneration after these impacts could result in good lynx/hare habitats. Others expressed uncertainty about whether fire and insect impacts would be temporary or permanent, especially considering climate change and the potential for conversion from boreal/subalpine forests to other forest types. Higher-quality lynx habitat in this unit occurs primarily in 2 areas and is patchily-distributed. Lynx in this unit may occur as several smaller, relatively isolated subpopulations, which are likely more vulnerable to stochastic events. This unit's relative isolation may limit exchange with other lynx populations, increasing the likelihood of genetic drift and reducing the chance of demographic rescue or recolonization if lynx in the unit become extirpated. There was discussion about whether ski areas may affect daily movements of lynx, and whether hares may be declining in ski areas. There is some evidence of lynx using ski areas in summer months but avoiding them during the ski season. Two-thirds to three-quarters of the lynx in this unit are in its southern portion in the San Juan Mountains. There is a large area (Weminuche Wilderness) that has not been well surveyed for lynx, so it is possible that lynx also could be using that area.

Taking these factors into consideration, experts provided "most likely" persistence estimates of 60 to 100 percent (median = 90 percent) in the near-term (year 2025), 50 to 85 percent (median = 80 percent) at mid-century (2050), and 20 to 70 percent (median = 50 percent) at the end of the century (2100; fig. 15). Most experts indicated an initially high and subsequently decreasing likelihood that resident lynx will persist in this unit, with uncertainty increasing substantially over time; however, experts also expressed substantial uncertainty over the near- and mid-term.

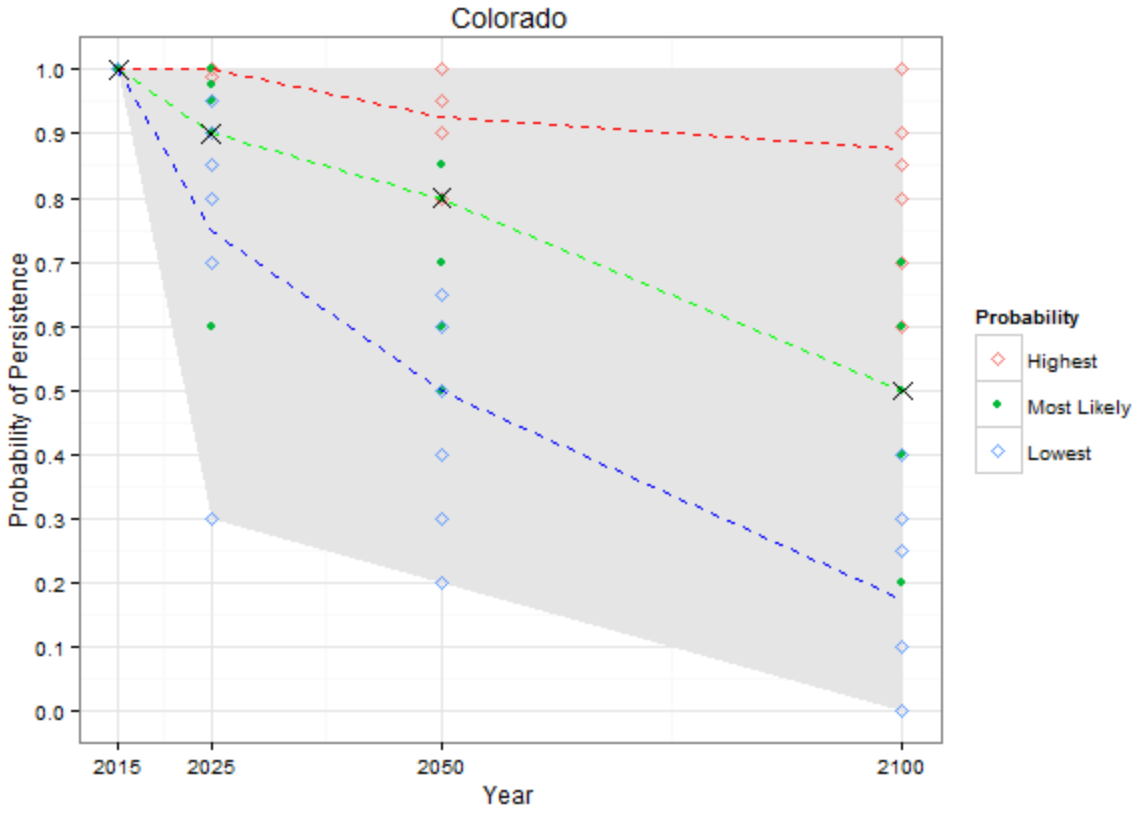


Figure 15. Expected probability of persistence for the Western Colorado Geographic Unit at present, 2015, and in 2025, 2050 and 2100.

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - Regulatory mechanisms for the conservation of lynx in the Southern Rockies consist of 7 amended USFS management plans in south-central Wyoming and Colorado. We concluded that the Southern Rockies Lynx Amendment substantively reduced the threat identified for previously inadequate regulatory mechanisms by addressing the major adverse impacts of Forest Service land management on lynx (USFWS 2008b, p. 70-71). Lynx habitat on all other ownerships makes up the remaining 15 percent of potential lynx habitat in Colorado, of which, only 5 percent is in Federal ownership. Other ownerships include state, county, municipal, etc., and private lands. Some BLM resource management plans have not been amended to include conservation specifically for lynx. Lynx habitat on BLM ownership mostly consists of narrow forest extensions connected to larger blocks of habitat on adjacent USFS lands. Generally these extensions are insufficient on their own to support a lynx home range. Additionally, the Gunnison Field Office is the only BLM unit that contains sufficient habitat to map and identify LAUs. The State of Colorado manages lynx as a State endangered species (C.R.S. 33-2-105), prohibiting take of the species with exceptions for protection of human life (C.R.S. 33-6-205) and incidentally during depredation management (not caused by lynx; C.R.S. 33-6-207).

Climate Change -In the Southern Rockies, warmer winters, earlier spring snowmelt, and a reduction in the extent of snow cover are expected consequences of climate change (ILBT 2013, p. 61). Using a variety of climate models, McKelvey *et al.* (2011, entire) predicted an overall 40 percent decline in persistent snow, but that snow would persist in large areas late in the 21st century, including the high elevations of Colorado.

"All of the climate models under all representative concentration pathways (RCPs) project that Colorado's climate will warm substantially by 2050. Under RCP 4.5 (medium-low emissions scenario), Colorado's annual temperatures are projected to warm by 1.4° to 2.8°C (2.5° to 5°F) by mid-century relative to the observed 1971–2000 baseline. Under RCP 8.5 (high emissions scenario), Colorado's annual temperatures are projected to warm by 1.9° to 3.6°C (3.5° to 6.5°F) by mid-century. Summers are projected to warm slightly more than winters under both RCPs. Beyond mid-century, the warming trend is projected to continue into the late-21st century under all RCPs except RCP 2.6. By the period centered on 2070 (2055–2084), annual temperatures in Colorado are projected to warm under RCP 4.5 by 1.4° to 3.6°C (2.5° to 6.5°F) relative to the 1971–2000 baseline. Under RCP 8.5, the projected warming is 3.1° to 5.3°C (5.5° to 9.5°F) relative to the 1971–2000 baseline." [Lukas *et al.* 2014, p. 61]

An analysis of projected 21st century temperature trends as a function of elevation in the Northern Hemisphere mid-latitudes from CMIP5 models shows more warming at higher elevations during winter, particularly in the daily minimum temperature (Rangwala *et al.* 2013 [cited in Lukas *et al.* 2014, p. 63]). "However, …, the global climate models do not represent the topography of Colorado very well, so it is difficult to discern whether the warming projected for the higher elevation regions (> 10,000') in the state is substantially different from that projected for lower elevations" (Lukas *et al.* 2014, p. 63).

On average, the climate models indicate a seasonal shift in precipitation for Colorado, with increasing winter precipitation, and in some areas a decrease in late spring precipitation (Lukas *et al.* 2014, p. 65). Although recent climate projections suggest that snow water equivalent (the amount of water held in a given amount of snow) may decline less in Colorado than in other areas of the Southwest, it is nonetheless projected to decline by 26 percent by the end of this century (Garfin *et al*. 2014, p. 466). This will likely translate to a reduction in the areas that will continue to have snow conditions that provide a competitive advantage to lynx over bobcats and other hare predators. Additionally, when specifically modeling potential impacts of climate change on lynx, researchers concluded that potential snow and boreal forest habitat refugia were most likely to occur in the Bridger-Teton National Forest in northwestern Wyoming, the Superior National Forest in northeastern Minnesota, and across western Canada, while high-elevation parts of Colorado are among the areas vulnerable to the loss of potential lynx habitat in the long term (Gonzalez *et al*. 2007, pp. 4, 8). Decker and Fink (2014, pp. 66-69) concluded that spruce-fir habitats in Colorado are only moderately vulnerable to the effects of climate change by mid-century under a moderate emissions scenario. Even if suitable snow conditions persist in Colorado and boreal and subalpine forests move upslope with continued climate warming, the amount of potential lynx habitat, already considered patchy and relatively isolated,

will likely decrease, becoming even more patchy and isolated and less capable of supporting lynx populations over time (79 FR 54794-54795).

We believe that continued climate warming will likely result in loss of favorable snow conditions, upslope migration of boreal forests, and increased frequency, size and intensity of wildlfires and forest insect outbreaks in this geographic unit. We believe these factors will exacerbate the naturally highly-fragmented distribution of potential lynx habitat in this geographic unit and further diminish what already appear to be marginal hare densities in most of this unit. As a result, we expect this unit's ability to continue to support a resident lynx population will become more tenuous in the future than it is currently and likely was historically.

Vegetation Management - In the past decade, vegetation management within lynx habitat has been predominantly salvage of dead and dying timber caused by a mountain pine beetle infestation in the northern part of the state (generally north of Interstate 70), and a spruce bark beetle infestation south of the interstate. Salvage operations may temporarily impact understory regeneration, if present, reducing the capacity of the stand to support higher snowshoe hare densities. Assuming the existing USFS plans retain their current conservation framework, USFS lands should continue to provide sufficient habitat for lynx through the end of the century. Vegetation management on the small amount of non-Federal ownerships within lynx habitat is unlikely to cause significant concern for lynx conservation in Colorado through the remainder of the century.

Wildland Fire Management - "It is generally acknowledged that in the Southern Rocky Mountains fire suppression has altered historical vegetative patterns. This effect has been most pronounced within vegetation communities where fire regimes are of low intensity or mixed severity. It is generally agreed that spruce-fir habitats have been little affected by fire suppression because the fire regimes within this type tend to be stand-replacing events occurring at long intervals (100+ years). Depending on the moisture regime, large stand-replacing fires within lynx habitat may produce young age class snowshoe hare habitat after approximately 10-30 years. Although this vegetative condition may provide some high-quality snowshoe hare habitat, mature forests are also very important as winter foraging habitat." (USFS 2008b, p. 36).

Habitat Fragmentation - Sources of current habitat fragmentation include high-speed high-volume highways, high mountain valley developments, vegetation management, ski/recreation area development, and wildland fire. Currently, only vegetation management on USFS lands is managed to limit lynx habitat fragmentation. Highways are likely to be expanded to accommodate increasing traffic volume as mountain valley communities continue to develop and expand. While these linear features already exist on the landscape, widening of the cleared right-of-way, as well as lynx behavioral avoidance of highway rights-of-way because of increasing traffic volume reduces available habitat function for lynx. Many ski areas in Colorado are located within lynx habitat and will likely be expanded in the future through permanent removal of vegetation to create conventional ski runs, reducing tree density and clearing understory vegetation to create glade conditions, which reduces lynx habitat. The magnitude of

fragmentation caused by these sources has not been quantified, but is unlikely to remove enough lynx habitat to influence lynx persistence in Colorado.

Conclusion

Based on the best scientific information available, the Core Team is less optimistic than the expert panel about the future of lynx in western Colorado. Our uncertainty stems primarily from the historic record of lynx in Colorado, where evidence of lynx presence is questionable for much of the last century prior to CPW's reintroduction program. In addition, several demographic parameters of this new population (proportion of females that produce kittens and kitten survival), are very low compared to other units (1 and 3) where these parameters have been estimated based on adequate sample sizes. Further, the naturally limited and fragmented habitats and generally low hare densities, which were apparently incapable of supporting persistent resident populations historically, are likely to worsen with continued climate warming. This unit's greater distance and relative isolation from other lynx populations in the DPS and Canada, which may have prevented dispersing lynx from reaching this unit during the unprecedented irruptions from Canada into the northern contiguous United States in the early 1960s and early 1970s, also cast doubt on the likelihood that this unit will receive the demographic and genetic support from the north that is thought to be important to the maintenance of DPS populations. Because of these factors and uncertainties, we doubt that resident lynx will persist in this unit through the end of the century (2100), although we concur with experts that lynx will persist over the short-term (2025) and possibly until mid-century (2050).

We have considered the future of lynx in Colorado in the absence of the protections offered by the ESA. We believe that as long as the current regulatory mechanisms provided by the State of Colorado to prevent take of lynx and the USFS SRLA conservation framework remains in place, lynx are likely protected from take, and their habitat requirements likely met in a significant majority of the potential habitat within the state. Projected future climate warming is likely to result in reduction of available habitat and increased fragmentation resulting in larger areas of non-habitat between habitat blocks. Vegetative changes caused by climate change will likely reduce the amount of habitat in private and BLM ownership due to the anticipated upslope shift in vegetation that supports snowshoe hares and lynx.

The movement capability of lynx is well documented, and lynx in Colorado will likely continue to exploit the available habitat despite gaps between functional habitat blocks. Colorado is isolated from source populations in the northern part of the range relative to the other units, which likely increases the possibility of genetic drift in this unit. Expert elicitation revealed some uncertainty whether ski areas or other development may affect connectivity within the unit. However, the Core Team is less concerned about this particular issue because we cannot foresee the development of barriers that would prevent lynx from accessing available lynx habitat in the future.

Chapter 6: Synthesis

This section synthesizes the needs, current condition, and likely future condition of the Canada lynx in the contiguous United States DPS with respect to the conservation biology principles of representation, redundancy, and resiliency. Its purpose is to provide an understanding of the range-wide status of the DPS that is as clear as possible given irresolvable uncertainties regarding historical distribution and population sizes, as well as uncertainty about current population sizes and trends, other key demographic information (e.g., immigration and recruitment rates and their influence on population stability/persistence), and the timing and magnitude of projected climate-mediated impacts and other long-term stressors.

Species' Needs

Throughout its range, the Canada lynx is a habitat and prey specialist requiring large (hundreds to thousands of square kilometers) boreal forest landscapes with dense horizontal cover and robust populations of its primary prey, the snowshoe hare. Resident lynx populations are generally restricted to areas with abundant hares and long (4+ months) winters with deep, persistent snow, which is believed to confer lynx a seasonal competitive advantage over other terrestrial predators of hares. Lynx in the contiguous United States have ecological requirements similar to those of lynx in Canada and Alaska, and throughout the species' range hare abundance is the primary driver of lynx population dynamics. Recent research in the DPS range supports the hypothesis that hare densities consistently near or above 0.5 hares/ha (0.2 hares/ac) are necessary to support persistent resident lynx populations (see section 2.2.1). However, the DPS is at the southernmost margin of the species' range, where boreal forests transition to temperate conifer and hardwood forests, and where hare abundance and snow conditions generally become less favorable with decreasing latitude. Because of this, habitat is naturally less extensive and generally more fragmented within the DPS range than in the core of the species' range in Canada and Alaska. As a result, lynx in much of the DPS range are naturally less abundant and more patchily-distributed than in the core of the species' range (except during decadal lows in hare population cycles, when both hares and lynx occur temporarily in the north at densities lower than most in the range of the DPS). Maintaining connectivity with lynx populations in Canada is thought to be important to the persistence of DPS populations; however, whether, and if so to what extent, the demographic and/or genetic health of DPS populations relies on periodic immigration from Canadian populations remains uncertain.

Current Conditions and Threats

Resiliency, the ability to withstand stochastic disturbance events, and redundancy, the ability to withstand catastrophic events, are currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. Available information indicates that 5 out of 6 geographic units in the DPS (all but the GYA) currently contain resident breeding lynx populations. Although we lack precise historical and

current population-size estimates for all of the geographic units, lynx experts familiar with each unit provided their estimates of the number of resident lynx each unit could potentially support.

- Northern Maine (Unit 1) – This unit has likely supported resident lynx since at least the southward re-expansion of boreal spruce-fir forests into the northeastern United States during and following the Little Ice Age (see section 3.2). Currently, northern Maine is thought to support many more resident lynx than likely occurred historically, and many more than was known or suspected at the time the DPS was listed. This unit currently contains an unnaturally-high amount of high-quality hare habitat; the result of dense conifer regeneration following landscape-level clearcutting in the 1970s and 1980s in response to a large spruce budworm outbreak. These dense young regenerating conifer stands are much more extensive than they are thought to have been historically under natural disturbance regimes. However, habitat extent probably peaked in the late 1990s and early 2000s, and habitat quality is projected to decline in these stands over the next few decades as they age beyond 35-40 years post-harvest. This unit currently is thought to support the largest resident population in the DPS; perhaps 750-1,000 individual lynx (Vashon *in* Lynx SSA Team 2016a, p. 18). This geographic unit may also be the source of dispersing lynx that recently recolonized northern New Hampshire as well as several that temporarily established residency in northern Vermont. Some reproduction has been verified recently in both states, although neither was occupied when the DPS was listed, and resident lynx were thought to have been extirpated from New Hampshire.

- Northeastern Minnesota (Unit 2) – This unit supports many more resident lynx than was suspected when the DPS was listed, although how the current population compares to historical conditions is uncertain. When the DPS was listed, it was uncertain whether this unit supported any resident lynx or if historic records were of dispersing lynx associated with cyclic irruptions from Canada. Trapping records indicate strongly cyclic increases in lynx abundance in this unit in the 1930s through 1970s in association with decadal irruptions of lynx dispersing south from Canada. This unit currently supports a resident lynx population thought to number from 50-200 (Moen *in* Lynx SSA Team 2016a, p. 19). There is no information to suggest that this unit historically supported a larger resident population or a more extensive distribution of habitat capable of doing so.

- Northwestern Montana and Northeastern Idaho (Unit 3) – Recent research, monitoring, and habitat mapping refinements indicate that habitats capable of supporting resident lynx in this and other western geographic units are naturally less abundant and more patchily-distributed than was thought when the DPS was listed. For example, earlier estimates that western Montana supported 1,000 or more lynx were based on broad assumptions regarding habitat suitability and lynx distribution that are not supported by current understanding of lynx habitat requirements (see section 4.2.3). Currently, this unit is thought to be capable of supporting 200-300 resident lynx. How the current population compares to historical conditions is uncertain, but we find no evidence that this unit historically supported a larger resident population or a substantially broader distribution of habitat capable of doing so. Lynx habitats in this unit are naturally patchy

and fragmented due to topography and elevational and moisture (aspect) constraints. Wildfires have burned over 5,200 km^2 (2,008 mi^2; nearly 20 percent of the unit) of forest in this unit since 2000, although the amount that occurred in lynx habitat is uncertain. During the 2017 fire season alone, roughly 1,150 km^2 (444 mi^2; over 4 percent of the unit) burned, including the Rice Ridge and Reef fires, which together burned over 690 km^2 (267 mi^2) in the core of the Seeley Lake population's habitat[27]. Population-level impacts of these fires have not yet been demonstrated.

- North-central Washington (Unit 4) – Extensive wildfires over the past several decades have (probably temporarily) reduced the amount of high-quality lynx habitat and have likely caused a decline in lynx carrying capacity in this unit from perhaps 50 lynx (based on this unit's proportional contribution to the larger Okanogan LMZ) before the large fires to roughly 30 lynx currently (Lewis 2016, pp. 4-6). The Diamond Creek wildfire burned another large block of lynx habitat in the northern part of this unit in 2017. Because of this, the current number of resident lynx in this unit is likely lower than it was historically and when the DPS was listed. Additional fires in this unit before previously burned areas recover (10-40 years post-burn) would further reduce lynx numbers and make this geographic unit more vulnerable to extirpation. Because of these habitat impacts and remaining stressors to lynx, the Washington Department of Fish and Wildlife recently submitted, and the State Fish and Wildlife Commission adopted, a proposal to uplist lynx from threatened to endangered within the State.

- The Greater Yellowstone Area (GYA, Unit 5) – Based on evaluation of verified historic records, it is uncertain whether this geographic unit historically supported a small but persistent resident population or supported resident lynx only ephemerally. There are very few verified lynx records in the GYA from 1920-1999, but several resident lynx and evidence of reproduction were verified in the late 1990s and early 2000s (around the time the DPS was listed). In addition, at least 9 radio-marked lynx released in Colorado (see below) dispersed northward into or through this unit from 2003-2010, but no lynx have been detected in the GYA since 2010. Most places surveyed in Yellowstone National Park had hare densities clearly too low to support resident lynx. However, parts of the Wyoming Range south of the park, where many historical and most recent occurrences in this unit have been concentrated, had hare densities among the highest documented in the DPS range. No population estimates are available, but expert opinion suggests that this unit may only support 0-10 lynx, and we find no reliable evidence that it once supported a larger or persistent resident population.

- Western Colorado (Unit 6) – There currently are many more resident lynx in this unit than likely occurred historically, and many more than were known or suspected at the time the DPS was listed. There were even fewer verified records in this unit during the last century than in the GYA, and no reliable evidence of a resident breeding population. However, from 1999-2006, 218 Canadian and Alaskan lynx were released into the San

[27] https://inciweb.nwcg.gov/state/27/0/

Juan Mountains of southwestern Colorado. As a result of the subsequent reproduction of some of the released lynx and some of their offspring over several generations, resident lynx currently occupy this unit. When the DPS was listed in 2000, 27 of 41 lynx released in 1999 were still alive. The State of Colorado has concluded that its efforts have established a viable lynx population, and the State's lynx experts suggest this unit may currently support 100-250 resident lynx (Ivan *in* Lynx SSA Team 2016a, p. 47). Recent snow-tracking and camera surveys in the San Juan Mountains in the southern part of the unit documented evidence of continued lynx residency and reproduction.

The apparent long-term (historical and current) persistence of resident lynx populations in at least 4 of the 6 geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historical conditions suggest the historical and recent resiliency of lynx populations in the DPS. The current resident population in Unit 6 has also demonstrated resiliency thus far. The large sizes and broad geographic distributions of the areas occupied by resident lynx populations likewise indicate historical and current redundancy in the DPS sufficient to preclude the possibility of extirpation from catastrophic events.

Representation, the ability of a species to adapt to changing environmental conditions over time, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016a, p. 25). Information provided by lynx experts and geneticists indicates high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016a, pp. 12-14, 55-56). Hybridization with bobcats has been documented but is not considered a substantial current threat to the DPS (Lynx SSA Team 2016a, p. 13). Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Thus, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous United States. There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historical conditions.

The lack of regulations protecting lynx habitat from potential threats on Federal lands at the time of listing has been largely addressed by formal and binding amendments or revisions to most Federal land management plans within the DPS range. Although uncertainty remains about the efficacy of this improved regulatory framework, Federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands. Most Federal lands, which constitute 64 percent of lynx habitat evaluated in this SSA, are found in the western United States.

Climate change is occurring at a global and, thus, a DPS-wide scale. Climate warming has reduced snow amount, duration, and quality (in terms of conditions thought to be favorable for lynx); it has been linked to increased frequency, size, and severity of wildfires and forest insect outbreaks; and it likely has already resulted in some changes in forest vegetative communities. Climate warming has also been suggested as contributing to changes in the amplitude, periodicity, and synchronicity of northern hare population cycles, which could alter (and perhaps have already altered) the timing and magnitude of lynx dispersal from Canada into the contiguous United States. If lynx populations in the DPS depend on immigration from Canada which is no longer occurring or has been reduced substantially relative to historical conditions, population declines and an increased likelihood of extirpation among resident DPS populations would be expected. However, whether, and if so to what extent, these climate-mediated factors have influenced current lynx numbers, other demographic parameters, and/or habitat quality and distribution is uncertain and has not been quantified across the range of the DPS or in individual geographic units. Despite uncertainty regarding its influence over current conditions for lynx, climate modeling and expert opinion concur that continued climate warming will adversely impact lynx in the DPS at some point in the future (also see *Future Conditions and Threats*, below).

There are other current stressors that are not occurring across the entire DPS range but which affect lynx in 1 or more geographic units. For example, in northern Maine, where most high-quality lynx habitat occurs on private commercial timber lands and is the result of past timber harvest, changes in State forestry regulations (the Maine Forest Practices Act of 1989) that govern private forest management may currently be facilitating decreases in habitat quantity, quality, and distribution, and may result in reduced lynx numbers (also see *Future Conditions and Threats*, below). The lack of binding lynx conservation commitments on most private lands may exacerbate this risk to current lynx habitats in Maine. However, the current amount and distribution of high-quality lynx and hare habitats created in Maine by past timber harvest is thought to be several times higher than the likely natural historical condition. In North-central Washington, recent large-scale wildfires have resulted in the temporary loss of over a third of lynx habitat, likely reducing this unit's current lynx population and potentially compromising its current ability to support a resident population until habitats recover. Increased wildfire activity also has impacted lynx habitats in the other western geographic units (Northwestern Montana/Northeastern Idaho, the GYA, and Western Colorado), but the extent to which it may have influenced the current condition of lynx populations in those units is uncertain.

Future Conditions and Threats

In our future condition analysis, including expert elicitation, we considered three time periods (2025, 2050, and 2100), with greater uncertainty in predicting effects to lynx and lynx habitat the further out we look into the future. Compared to the other time periods, predictions out to 2100 are complicated by considerably higher uncertainty. Overall, our evaluations of the scientific literature and expert input suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of

boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations; Lynx SSA Team 2016a, p. 58). Forest management on private lands that lack lynx conservation commitments may also contribute to future declines, particularly in northern Maine. In each geographic unit, the probability that resident lynx populations will persist is expected to decline through the end of the century, with uncertainty about the rate of decline increasing with time from the present. The loss of resident lynx from 1 or more geographic unit would represent reduced future resiliency, redundancy, and representation within the lynx DPS.

The resiliency of lynx populations in individual geographic units is the primary determinant of the future viability of the lynx DPS. Our analyses and expert predictions suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations are also likely to decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, other terrestrial hare predators (e.g., bobcats and coyotes) may outcompete and displace lynx. This in turn would reduce lynx abundance and density within populations, making populations more susceptible to stochastic events.

Here we present future condition analysis summaries for each geographic unit (also see table 1 and figure 2):

- Northern Maine (Unit 1) – We concur with the expert panel that the resident lynx population in this unit is very likely to persist at 2025 and at 2050. Over the longer-term (at 2100), we expect continued climate warming to reduce the amount and quality of lynx habitat in this unit and exacerbate other potential stressors (commercial and energy developments, changing forestry practices and land ownership patterns, etc.), further reducing lynx numbers and decreasing the population's resilience. Some climate models indicate substantial loss of boreal forest and favorable snow conditions under higher emissions scenarios, and this unit generally lacks potential elevational refugia that would support upslope movement of lynx habitats and populations. Therefore, we suggest that the likelihood that this unit will support a resident lynx population at 2100 may be somewhat lower than expert projections, although the timing and extent of future climate-mediated habitat decline is highly uncertain.

- Northeastern Minnesota (Unit 2) – We concur with the expert panel that the resident lynx population in this unit is very likely to persist at 2025 and at 2050. Over the longer-term (at 2100), we expect continued climate warming to reduce the amount and quality of lynx

habitat in this unit, likely reducing lynx numbers and decreasing the population's resilience. Under higher emissions scenarios, some climate models project substantial loss of boreal forest and favorable snow conditions in this unit before the end of the century. Like Maine, this unit also lacks potential elevational refugia that would support upslope movement of lynx habitats and populations. Therefore, we suggest that the likelihood that resident lynx will persist in this unit at 2100 may be somewhat lower than expert projections, although the timing and extent of climate-mediated habitat decline is highly uncertain.

- Northwestern Montana and Northeastern Idaho (Unit 3) – We concur with the expert panel that resident lynx are very likely to persist in this unit at years 2025 and 2050, and likely to do so at 2100. Over the longer-term, we expect continued climate warming and associated impacts, perhaps especially increased wildfire activity, to reduce the amount and quality of lynx habitat in this unit, reducing lynx numbers and likely decreasing the population's resilience. Although the timing and extent of climate-mediated habitat decline is highly uncertain and fire-driven habitat loss typically would be temporary, wildfire size, frequency, and intensity have increased in this unit over the past few decades, and this pattern is expected to continue with projected climate warming.

- North-central Washington (Unit 4) – We concur with the expert panel that the resident lynx population in this unit is very likely to persist at years 2025 and 2050. Over the longer-term (2100), we expect continued climate warming to reduce the amount and quality of lynx habitat in this unit, further reducing lynx numbers and likely decreasing the population's resilience. Therefore, we concur with experts that this unit has a relatively lower likelihood of supporting a resident population at 2100, although the timing and extent of climate-mediated habitat decline is highly uncertain.

- The Greater Yellowstone Area (GYA, Unit 5) – Given the uncertainty whether this unit historically or recently supported a persistent resident population and the lack of evidence that it is currently occupied by resident lynx, we concur with experts that it is very unlikely to support a resident population in the future.

- Western Colorado (Unit 6) – We concur with the expert panel that resident lynx in this unit are likely to persist at year 2025. However, given this unit's apparent historical inability to support a persistent resident population, its relative isolation from other lynx populations, its naturally fragmented habitat and generally very low hare densities, and its generally lower proportion of females producing kittens and low kitten survival, we believe it is less likely than expert projections to support a resident population at 2050 or at 2100. It is possible that hare densities will increase over the next several decades as large areas of forest regenerate from recent extensive insect and fire impacts. However, we expect any increase in hares to be temporary and accompanied by a longer-term insect- and fire-driven decrease in red squirrel (an important alternate prey species in this unit) abundance.

The loss of resident lynx populations in any geographic units would also reduce the level of redundancy and could diminish representation within the DPS. With regard to redundancy, however, we find that none of the 5 geographic units that currently support resident lynx is vulnerable to extirpation from a single catastrophic event. Given that, we conclude that the DPS as a whole is not vulnerable to extirpation from a catastrophic event. We recognize that a sequence of discrete but spatially-clustered catastrophic events in lynx habitats over a short time could increase the potential for functional extirpation in 1 or more of the individual geographic units (especially the possibility of additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in 1 or more units within the DPS, extirpation of the DPS from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and likely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Furthermore, based on expert input, we conclude that there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (Lynx SSA Team 2016a, p. 51). This information suggests the current and likely future relative genetic health of the DPS. However, the potential for genetic drift would be expected to increase at some point in the future if lynx and hare habitats shift northward and upslope, as projected with continued climate warming, resulting in reduced connectivity and gene flow among smaller and more isolated lynx populations at the periphery of the range (Schwartz 2017, pp. 4-5; also see section 3.2).

How the potential loss of resident lynx from 1 or more geographic units may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr [106 in/yr]) is almost twice that observed in Minnesota (140 cm/yr [55 in/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Given the high percentage of Federal land ownership in the West, regulatory commitments that these lands will continue to be managed in accordance with lynx conservation principles, and

the existence of potential high-elevation climate refugia to which lynx habitats and some lynx might move, the western geographic units (Units 3-6) may be more likely to support resident lynx longer under projected continued climate warming. Nonetheless, it is unlikely that any management actions can abate the long-term northward and upslope retreat of boreal forests and diminished snow conditions projected by climate models. Further, the size, frequency, and intensity of wildfires and forest insect outbreaks are expected to increase with continued climate warming, particularly in the western portion of the DPS, although we do not anticipate such events in-and-of-themselves are likely to cause the permanent loss of breeding lynx populations in any geographic unit.

Projections of climate-mediated losses of boreal forests and favorable snow conditions suggest impacts to lynx and hare populations throughout the DPS. However, persistence of resident lynx in Maine and Minnesota may be relatively lower than the western geographic units given the smaller percent of Federal lands and the absence of associated regulatory commitments to lynx conservation, and the lack of potential elevational refugia. Additionally, as noted above, changes to regulations governing timber harvest on private forest lands in Maine are unlikely to maintain the current historically-high amount and distribution of good lynx habitat or the current large population of resident lynx. These changes, which may affect over 90 percent of lynx habitats in northern Maine, are projected to result in substantial declines in habitat quality and distribution, and lynx numbers, over the next 10-30 years, primarily through restrictions on clearcutting and the proliferation of partial harvesting. On private forest lands, energy development (wind energy, mining), rapid turnover in ownership and parcelization of forest land, and uncertain forest markets may also reduce the future quality and quantity of lynx habitat.

DPS Viability

Resident lynx populations persisted historically and continue to persist in 4 geographic units (Units 1-4). It is uncertain whether Unit 5 (the GYA) historically supported a small persistent population or if lynx residency was ephemeral; currently, it appears not to support resident lynx. Available evidence suggests that Unit 6 (Colorado) did not historically support persistent lynx presence; however, a resident population has persisted there for more than a decade since the 1999-2006 releases described above. Considering the available information, we find no reliable evidence that the current distribution and relative abundance of resident lynx in the contiguous United States are substantially reduced from historical conditions. This suggests historical and current resiliency among lynx populations in the DPS.

The current broad distribution of resident lynx in large, geographically discrete areas (redundancy) makes the DPS invulnerable to extirpation caused by a single catastrophic event. Because we lack evidence that formerly persistent lynx populations have been lost from any large areas, it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. In fact, as a result of the current population in Colorado, redundancy in the DPS is likely greater, at least temporarily, now than it was historically.

Similarly, resident lynx remain broadly distributed across the range of habitats that has supported them historically, suggesting maintenance of the breadth and diversity of ecological settings occupied within the DPS range (representation). Additionally, observed high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the lynx's range, including the DPS, suggest the past and recent genetic health of lynx populations in the DPS (representation; but see section 2.1). Because there are no indications of significant loss of or current stressors to the genetic health or adaptive capacity of lynx populations in the DPS, we find that the current level of representation within the DPS does not appear to indicate a decrease from historical conditions.

In the future, we expect lynx populations in each geographic unit to become smaller and more patchily-distributed due largely to projected climate-driven losses in habitat quality and quantity and related factors. However, the timing, rate, and extent of habitat decline due to projected climate warming and corresponding effects to lynx populations is highly uncertain. Despite some reduced resiliency, we conclude that resident lynx populations are very likely to persist in all 5 units that currently support them (Units 1-4 and 6) in the near-term (2025) and in all or most of those units at 2050, with corresponding maintenance of redundancy and representation in the DPS over that time span. We and the experts we consulted have low confidence in predicting the likely conditions of DPS populations beyond 2050. That said, smaller, more isolated populations would be less resilient and more vulnerable to demographic and environmental stochasticity and genetic drift and, therefore, at higher risk of extirpation. Although predictions out to 2100 are highly uncertain, it is possible that resident lynx populations could be functionally extirpated from some units by the end of the century. Should future extirpations occur, this would indicate a loss of resiliency, reduced redundancy and representation, and an increased risk of extirpation of the DPS.

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From: Jacobsen, Dana
To: Willey, Seth
Cc: Michael Thabault; Bridget Fahey; Jim Zelenak; Jodi Bush; Brent Esmoil
Subject: Re: From Greenwire -- ENDANGERED SPECIES: Judge sets deadline for lynx preservation plan
Date: Tuesday, December 02, 2014 2:45:21 PM

Great, thanks!

On Tue, Dec 2, 2014 at 2:43 PM, Willey, Seth <seth_willey@fws gov> wrote:

> Hey Dana,
>
> (b) (5) attorney client [redacted]
>
> I have suggested that we start by developing a project plan (Jim et al , see my Oct 10 email for examples, etc) That would be a tangible product to attach and provide It would include our anticipated timeline, including how the 5-year review fits in (a priority per a previous Jodi email) Given cross regional elements, we should chat about how to get this done in time, if we decide that is the plan
>
> Seth
>
> ************************************
> Seth L Willey
> Assistant Regional ESA Chief &
> Regional Recovery Coordinator
> USFWS, Mountain-Prairie Region
> Seth_Willey@fws gov
> 303-236-4257
> ************************************
>
> On Tue, Dec 2, 2014 at 2:16 PM, Jacobsen, Dana <dana jacobsen@sol doi gov> wrote:
>
> > Hi all,
> >
> > (b) (5) attorney client [redacted]
> >
> > Dana J.
> >
> > On Thu, Jun 26, 2014 at 11:58 AM, Willey, Seth <seth_willey@fws gov> wrote:
> >
> > > According to press reports, we got our dates but will have to submit semi-annual progress reports (each January & July)
> > >
> > > ************************************
> > > Seth L Willey
> > > Assistant Regional ESA Chief &
> > > Regional Recovery Coordinator
> > > Seth_Willey@fws gov
> > > 303-236-4257
> > > ************************************
> > >
> > > ## Judge sets 2018 deadline for effort to save lynx
> > >
> > > By MATTHEW BROWN, Associated Press
> > > Updated 4:03 pm, Wednesday, June 25, 2014
> > >
> > > ---
> > >
> > > FILE - in this April 19, 2005 file photo, a Canada lynx heads into the Rio Grande National Forest after being released near Creede, Colo. Wildlife advocates want a federal judge to force the government to move more quickly on a recovery plan for imperiled Canada lynx. The U.S. government declared the snow-loving big cats a threatened species across the Lower 48 states in 2000. But officials haven't come up with a mandated recovery plan. Photo: David Zalubowski, AP
> > >
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> > >
> > > BILLINGS, Mont. (AP) — A federal judge on Wednesday set a 2018 deadline for the government to complete a long-delayed recovery plan for imperiled Canada lynx in the Lower 48 states.
> > >
> > > Wildlife advocates had asked U.S. District JudgeDonald Molloy to push the government into faster action on the snow-loving big cats, which were added to the list of threatened species in 2000.
> > >
> > > But after federal officials said budget issues and competing priorities were slowing their work, Molloy indicated Wednesday in an order that he was reluctant to second-guess them. He said the January 2018 deadline proposed by the U.S. Fish and Wildlife Service was reasonable.
> > >
> > > "It will not disrupt the Service's other recovery work, but will also set a date certain by which the Service will be required to take action," the judge wrote.
> > >
> > > Molloy also ordered the agency to submit semi-annual progress reports each January and July.
> > >
> > > Federal officials were forced to come up with a timeline for the recovery document when Molloy last month expressed frustration with the government's track record of delays on the issue. The judge said the "stutter-step" approach by federal officials since the animal first gained protections necessitated court intervention.
> > >
> > > Advocates wanted the recovery plan done by the end of 2016.
> > >
> > > Lynx dwell in the forest, where they are rarely seen, and there's no reliable estimate of their population.
> > >
> > > They range across parts of 14 states in the Northeast, the Rocky Mountains, the Great Lakes and the Cascade Range of Washington and Oregon.
> > >
> > > Federal wildlife official say that lynx face a relatively low degree of threat compared to other protected species. They have proposed large areas in

Montana, Wyoming and other states as critical habitat for the lynx. The recovery plan would detail the additional steps needed to ensure the species' long-term survival.

But a coalition of conservation groups sued the government last year for not completing that document more than a decade after lynx received federal protections.

The plaintiffs in the case are Friends of the Wild Swan, Rocky Mountain Wild, Biodiversity Conservation Alliance and the San Juan Citizens Alliance.

---------- Forwarded message ----------
From: seth_willey@fws.gov **by E&E Publishing** <email_this@eenews net>
Date: Thu, Jun 26, 2014 at 11:50 AM
Subject: From Greenwire -- ENDANGERED SPECIES: Judge sets deadline for lynx preservation plan
To: seth_willey@fws gov

This Greenwire story was sent to you by: seth_willey@fws gov

Greenwire

An E&E Publishing Service

ENDANGERED SPECIES: Judge sets deadline for lynx preservation plan (Thursday, June 26, 2014)

A federal judge yesterday accepted a 2018 deadline proposed by the Fish and Wildlife Service for the government to finish a recovery plan for the Canada lynx in the contiguous United States

Conservation groups sued the government last year for failing to complete a plan to save the big cat more than 10 years after it was listed as a threatened species Plaintiffs, including Friends of the Wild Swan, Rocky Mountain Wild, the Biodiversity Conservation Alliance and the San Juan Citizens Alliance, wanted the plan to be completed by 2016

Although he said the agency's "stutter-step" approach necessitated court intervention, U S District Judge Donald Molloy said he was reluctant to second-guess officials with tight budgets and competing priorities

It's hard to pin down population levels of the elusive forest-dwellers, found in 14 states Federal wildlife officials say the species faces a lower threat than other protected creatures (Matthew Brown, AP/*Seattle Post-Intelligencer*, June 25) -- **DTB**

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Dana Jacobsen
Assistant Regional Solicitor
Rocky Mountain Regional Office

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From: Bush, Jodi
To: Zelenak, Jim
Subject: Re: Next Court Update - Lynx Recovery Planning
Date: Monday, June 13, 2016 9:15:35 AM

This looks good to me. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Jun 13, 2016 at 8:02 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Thanks Dana,
>
> I took a stab at addressing your suggestion - let me know if that is adequate or if more detail is necessary.
>
> Seth - please share with anyone else in the RO who you think needs to see/review this before Dana sends it to DOJ. If you or others have comments, suggestions, edits, please send them to Dana - I will be out of the office starting tomorrow, returning next Tues., the 21st, and I can make additional tweaks then if not finalized this week.
>
> Thanks
>
> On Mon, Jun 13, 2016 at 7:22 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
>
> > Hey Jim,
> >
> > (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
> > (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
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> > (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
> > (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
> > (b)(5)
> > attorney
> >
> > Thanks so much!!
> >
> > Dana J.
> >
> > On Fri, Jun 10, 2016 at 3:41 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > I'm going to be out of the office for a week beginning next Tues. and thought it might be helpful to draft a few bullets for the next update due to the court. I used the last one I had as a template.
> > >
> > > See attached and let me know if you have questions, comments, concerns or anything else to add (b)(5) attorney client
> > > (b)
> > > (5)
> > > tt
> > >
> > > I'll be in the office on Monday if we need to discuss, then back on June 21.

> > thx
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Dana Jacobsen
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(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Backsen, Sarah
To: Willey, Seth
Cc: Zelenak, Jim; Jacobsen, Dana; Jodi Bush
Subject: Re: Next Court Update - Lynx Recovery Planning
Date: Monday, June 20, 2016 8:12:30 AM

This is a belated response, but just wanted to let folks know I didn't have any comments to add on this. Thanks!

Sarah Backsen (Fierce)
Listing Biologist
U.S. Fish and Wildlife Service, Region 6
134 Union Blvd., Lakewood, CO 80228
303-236-4388
sarah_backsen@fws.gov
Please note the name change and new email address!

On Mon, Jun 13, 2016 at 4:21 PM, Backsen, Sarah <sarah_backsen@fws.gov> wrote:

> Thanks. I didn't seem to get the attachment though, can someone resend?
>
> Sarah Backsen (Fierce)
> Listing Biologist
> U.S. Fish and Wildlife Service, Region 6
> 134 Union Blvd., Lakewood, CO 80228
> 303-236-4388
> sarah_backsen@fws.gov
> **Please note the name change and new email address!**
>
> On Mon, Jun 13, 2016 at 8:25 AM, Willey, Seth <seth_willey@fws.gov> wrote:
>
> > Adding Sarah is who is acting for me right now. Thanks Jim!
> >
> > **********
> > Seth L. Willey, *Acting* Chief of Staff
> > Office of the Regional Director
> > Mountain-Prairie Region, USFWS
> > Seth_Willey@fws.gov
> > 303-236-4257
> > **********
> > **ON DETAIL** - May 31st through June 24th, I'll be on a detail as acting Chief of Staff for the Regional Director's Office. Sarah Backsen will be acting for me during this period (sarah_backsen@fws.gov, 303-236-4388).
> >
> > On Mon, Jun 13, 2016 at 8:02 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Thanks Dana,
> > >
> > > I took a stab at addressing your suggestion - let me know if that is adequate or if more detail is necessary.
> > >
> > > Seth - please share with anyone else in the RO who you think needs to see/review this before Dana sends it to DOJ. If you or others have comments, suggestions, edits, please send them to Dana - I will be out of the office starting tomorrow, returning next Tues., the 21st, and I can make additional tweaks then if not finalized this week.
> > >
> > > Thanks

On Mon, Jun 13, 2016 at 7:22 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

Hey Jim,

(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
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(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client

Thanks so much!!

Dana J.

On Fri, Jun 10, 2016 at 3:41 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

I'm going to be out of the office for a week beginning next Tues. and thought it might be helpful to draft a few bullets for the next update due to the court. I used the last one I had as a template.

See attached and let me know if you have questions, comments, concerns or anything else to add (b)(5) attorney client (b)(5) tt

I'll be in the office on Monday if we need to discuss, then back on June 21.

thx

--
Jim Zelenak, Biologist
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From: Jodi Bush
To: Zelenak, Jim
Subject: Re: CANADA LYNX RECOVERY PLAN - DN 49 - STATUS REPORT Of Recovery Planning For The Canada Lynx by Daniel Ashe, S.M.R. Jewell, U.S. Fish and Wildlife Service, United States Department of the Interior. (Annatoyn, Travis)
Date: Sunday, December 11, 2016 9:06:14 PM

Looks fine. I'm assuming we will be able to provide the document to peer reviewers this week.
JB

Sent from my iPhone

On Dec 9, 2016, at 2:56 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Clean draft attached.
>
> I made your recommended changes.
>
> Jodi is out of office and may not see it until Monday or later. Looks like she will be out of the office until Thursday next week, but may be checking emails before then.
>
> On Fri, Dec 9, 2016 at 3:39 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
>
> > Great, thanks, Jim! (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client
> >
> > On Fri, Dec 9, 2016 at 3:05 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > I'm fine with your edits and the rationale behind them.
> > >
> > > (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client
> > >
> > > Let me know if you need anything else from here.
> > >
> > > On Mon, Dec 5, 2016 at 11:46 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
> > >
> > > > Hey there!
> > > >
> > > > Attached are some comments from me. See what you think. I'd like to circulate to DOJ by the end of the week if you think that is possible?
> > > >
> > > > Dana

On Tue, Nov 29, 2016 at 3:27 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

Jodi hasn't reviewed this yet, but she told me to send it to you so you can have a look.

(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5)
attorne

Thanks,

Jim

On Mon, Nov 28, 2016 at 3:01 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

Hey Jim! I haven't seen a draft yet. Thanks for checking in! Hope all is well.

Dana

On Mon, Nov 28, 2016 at 1:56 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

Hi Dana,

(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client

Jim

On Mon, Oct 31, 2016 at 11:45 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

Good morning,

In anticipation of needing to file a status report at the end of December, can FWS prepare a draft status report that I can share with DOJ? I attach the last report that was filed for reference.

Thanks.

Dana J.

---------- Forwarded message ----------
From: **Annatoyn, Travis (ENRD)** <Travis.Annatoyn@usdoj.gov>
Date: Mon, Jun 27, 2016 at 2:22 PM

Subject: CANADA LYNX RECOVERY PLAN - DN 49 - STATUS REPORT Of Recovery Planning For The Canada Lynx by Daniel Ashe, S.M.R. Jewell, U.S. Fish and Wildlife Service, United States Department of the Interior. (Annatoyn, Travis)
To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>

FYI.

Travis Annatoyn, Trial Attorney

United States Department of Justice

Environment and Natural Resources Division

601 D St. NW

Washington, D.C. 20004

travis.annatoyn@usdoj.gov

Tel: 202-514-5243

Fax: 202-305-0275

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jim_zelenak@fws.gov

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jim_zelenak@fws.gov

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jim_zelenak@fws.gov

<2016 12 09 Revised WILDLIFE-#288587-v1-_Lynx_RP__Status_Report_Dec_31_CONFIDENTIAL.doc>

From:	Bush, Jodi
To:	Bell, Heather
Cc:	Zelenak, Jim; Jacobsen, Dana; Willey, Seth; Justin Shoemaker; Mary Parkin; Nathan Allan/R2/FWS/DOI
Subject:	Re: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report
Date:	Wednesday, January 04, 2017 9:22:37 AM

Thanks Heather.

Nathan. If you have ideas on what that disclaimer paragraph should say(I assume it would just be in the email we send to them with the SSA as an attachment) -please provide. I will be sending the document out for Peer review in the next several days. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Wed, Jan 4, 2017 at 9:14 AM, Bell, Heather <heather_bell@fws.gov> wrote:

> Some Notes from my conversation. I have cc'd Nathan so he can better explain his thinking and can perhaps work on some language to include in the draft SSA as it goes to Peer Review (and other "public")
>
> The SSA should not reveal the decision, but it is pre- decisional in that it is a work in process (we don't have to give up things while we are still working on, isn't this an exemption in FOIA correct??). Nathan thinks that once we send it out for peer review it may be "public" and we should then make it available to the group requesting it or post it?? Although we would want to state that the document does not yet have the benefit peer review nor our ability to respond to it and therefore we, the FWS, does not believe it is a completed product. Nathan thinks a disclaimer paragraph could be inserted (talk with him directly as he is thinking about it right now!!!).
>
> Heather Bell
> Ecological Services HQ
> Division of Restoration and Recovery
> SSA Framework Team Lead
> Remotely Located at
> 134 S. Union Blvd
> Lakewood, CO 80228
> 303-236-4514
>
> Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the Recovery Planning and Implementation (RPI) Google Site: https://sites.google.com/a/fws.gov/recovery-planning-and-implementation/ For audiences outside FWS visit http://www fws.gov/endangered/improving_ESA/SSA html.
>
> On Wed, Jan 4, 2017 at 8:58 AM, Bell, Heather <heather_bell@fws.gov> wrote:

I am checking with Nathan Allan

Heather Bell
Ecological Services HQ
Division of Restoration and Recovery
SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the Recovery Planning and Implementation (RPI) Google Site: https://sites.google.com/a/fws.gov/recovery-planning-and-implementation/ For audiences outside FWS visit http://www.fws.gov/endangered/improving_ESA/SSA.html.

On Wed, Jan 4, 2017 at 8:45 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

I've copied Heather, Mary, Seth and Justin on this attorney-client privilege string to get their thoughts.

Heather, Mary, Seth, Justin:

We are required to submit twice-a-year (end of June and end of Dec.) updates to the court in the lynx recovery plan lawsuit case - these outline what progress we've made every 6 months toward our agreement to complete a recovery plan by Jan. 2018 unless we determine one is not needed. These updates are also available to plaintiffs. Last update indicated we would be sending draft SSA Report to peer reviewers by end of Dec. (which we didn't do as we are still working thru some formatting issues, but hope it goes out in next couple days) and State and other partners soon after.

When we completed the EE Workshop report, we posted it to our R6 lynx webpage and made it available to the public, including plaintiffs and other NGOs.

(b)(5)DPP (b)(5)DPP (b)(5)DPP (

Sent from my iPhone

On Jan 3, 2017, at 1:14 PM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:

> Please see below. Let me know what you think.
> ---------- Forwarded message ----------
> From: **Annatoyn, Travis (ENRD)** <Travis.Annatoyn@usdoj.gov>
> Date: Tue, Jan 3, 2017 at 1:04 PM
> Subject: FW: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report
> To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>
>
> Hi Dana:
>
> See below. (b)(5)DPP (b)(5)DPP (b)(5)DPP (b)(5)DPP (b)(5)DPP (b)(5)DPP (b)(5)DPP
>
> Travis Annatoyn, Trial Attorney
>
> United States Department of Justice
>
> Environment and Natural Resources Division
>
> 601 D St. NW
>
> Washington, D.C. 20004
>
> travis.annatoyn@usdoj.gov
>
> Tel: 202-514-5243
>
> Fax: 202-305-0275
>
> ---
>
> **From:** Matthew Bishop [mailto:bishop@westernlaw.org]
> **Sent:** Tuesday, January 03, 2017 11:38 AM
> **To:** Annatoyn, Travis (ENRD) <TAnnatoyn@ENRD.USDOJ.GOV>
> **Cc:** bishop@westernlaw.org; 'John Mellgren' <mellgren@westernlaw.org>

Subject: FW: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report

Hi Travis – nice to finally meet you in person in DC. I hope you had a good holiday break. Is it possible to send me a copy of the draft SSA report shared with the states and referenced in your filing or must I send a FOIA request? Thanks, Matt

Matthew Bishop

Western Environmental Law Center

103 Reeder's Alley

Helena, Montana 59601

(406) 324-8011 (tel.)

bishop@westernlaw.org

www.westernlaw.org

From: MTD_CMECF@mtd.uscourts.gov [mailto:MTD_CMECF@mtd.uscourts.gov]
Sent: Friday, December 30, 2016 2:15 PM
To: MTD_CMECF@mtd.uscourts.gov
Subject: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report

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U.S. District Court

District Of Montana

Notice of Electronic Filing

The following transaction was entered by Annatoyn, Travis on 12/30/2016 at 2:14 PM MST and filed on 12/30/2016

Case Name:	Friends of the Wild Swan et al v. Ashe et al
Case Number:	9:13-cv-00057-DWM
Filer:	Daniel Ashe S.M.R. Jewell U.S. Fish and Wildlife Service United States Department of the Interior

WARNING: CASE CLOSED on 07/09/2014
Document Number: 50

Docket Text:
STATUS REPORT *Recovery Planning For The Canada Lynx* by Daniel Ashe, S.M.R. Jewell, U.S. Fish and Wildlife Service, United States Department of the Interior. (Annatoyn, Travis)

9:13-cv-00057-DWM Notice has been electronically mailed to:

John R. Mellgren mellgren@westernlaw.org

Matthew Kellogg Bishop bishop@westernlaw.org

Travis J. Annatoyn travis.annatoyn@usdoj.gov, efile_wmrs.enrd@usdoj.gov

9:13-cv-00057-DWM Notice has been delivered by other means to:

The following document(s) are associated with this transaction:

Document description: Main Document
Original filename:n/a
Electronic document Stamp:
[STAMP dcecfStamp_ID=1105468959 [Date=12/30/2016] [FileNumber=1800549-0] [12fb6f15daa45ca8a943948f20ea7edbf223bff8cd1c5aa98ad7685995b3966122
52110215c4521796313b62177db48dfc8ab1c90b01327962edff68ccedec8e]]

--
Dana Jacobsen
Assistant Regional Solicitor
Rocky Mountain Regional Office
Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Jacobsen, Dana
To: Bell, Heather
Cc: Zelenak, Jim; Jodi Bush; Willey, Seth; Justin Shoemaker; Mary Parkin; Nathan Allan/R2/FWS/DOI
Subject: Re: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report
Date: Wednesday, January 04, 2017 10:05:48 AM

Hi all,

(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client

Dana J.

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> Some Notes from my conversation. I have cc'd Nathan so he can better explain his thinking and can perhaps work on some language to include in the draft SSA as it goes to Peer Review (and other "public")
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> The SSA should not reveal the decision, but it is pre- decisional in that it is a work in process (we don't have to give up things while we are still working on, isn't this an exemption in FOIA correct??). Nathan thinks that once we send it out for peer review it may be "public" and we should then make it available to the group requesting it or post it?? Although we would want to state that the document does not yet have the benefit peer review nor our ability to respond to it and therefore we, the FWS, does not believe it is a completed product. Nathan thinks a disclaimer paragraph could be inserted (talk with him directly as he is thinking about it right now!!!).
>
> Heather Bell
> Ecological Services HQ
> Division of Restoration and Recovery
> SSA Framework Team Lead
> Remotely Located at
> 134 S. Union Blvd
> Lakewood, CO 80228
> 303-236-4514
>
> Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the Recovery Planning and Implementation (RPI) Google Site: https://sites.google.com/a/fws.gov/recovery-planning-and-implementation/ For audiences outside FWS visit http://www.fws.gov/endangered/improving_ESA/SSA.html.

On Wed, Jan 4, 2017 at 8:58 AM, Bell, Heather <heather_bell@fws.gov> wrote:

> I am checking with Nathan Allan
>
> Heather Bell
> Ecological Services HQ
> Division of Restoration and Recovery

SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

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To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>

Hi Dana:

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Travis Annatoyn, Trial Attorney

United States Department of Justice

Environment and Natural Resources Division

601 D St. NW

Washington, D.C. 20004

travis.annatoyn@usdoj.gov

Tel: 202-514-5243

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Case Number:	9:13-cv-00057-DWM
Filer:	Daniel Ashe S.M.R. Jewell U.S. Fish and Wildlife Service United States Department of the Interior

WARNING: CASE CLOSED on 07/09/2014
Document Number: 50

Docket Text:
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John R. Mellgren mellgren@westernlaw.org

Matthew Kellogg Bishop bishop@westernlaw.org

Travis J. Annatoyn travis.annatoyn@usdoj.gov, efile_wmrs.enrd@usdoj.gov

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The following document(s) are associated with this transaction:

Document description: Main Document
Original filename:n/a
Electronic document Stamp:
[STAMP dcecfStamp_ID=1105468959 [Date=12/30/2016] [FileNumber=1800549-0] [12fb6f15daa45ca8a943948f20ea7edbf223bff8cd1c5aa98ad7685995b3966122
52110215c4521796313b62177db48dfc8ab1c90b01327962edff68ccedec8e]]

--
Dana Jacobsen
Assistant Regional Solicitor

> > > Rocky Mountain Regional Office
> > > Office of the Solicitor
> > > 755 Parfet, Suite 151
> > > Lakewood, CO 80215
> > > (303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

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Assistant Regional Solicitor
Rocky Mountain Regional Office
Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

From:	Shoemaker, Justin
To:	Zelenak, Jim
Cc:	Jodi Bush; Marjorie Nelson; Seth Willey
Subject:	Re: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report
Date:	Wednesday, January 11, 2017 12:39:04 PM

I'd say include that language in the message to Dana, so its in two places, the document itself, and the transmission of the document.

Justin Shoemaker
Senior Listing Biologist
U.S. Fish and Wildlife Service, Region 6
1511 47th Avenue, Moline, IL 61265
Phone: 309-757-5800 ext. 214
Email: justin_shoemaker@fws.gov

On Wed, Jan 11, 2017 at 1:28 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Will do.
>
> Do we need to include some caveat language - other than the disclaimer on the draft itself:
>
> "NOTE ABOUT THIS DRAFT DOCUMENT, DECEMBER 2016
> This is a preliminary draft document of the U.S. Fish and Wildlife Service. This draft species status
> assessment report has not undergone peer review, and it should not be cited or referenced as an
> agency document. At this time it is intended for the sole purpose of soliciting scientific reviews
> from expert peer reviewers, from State and Federal partners with expert knowledge of the species
> and its habitat, and from internal reviewers by Department of Interior staff. The document is not
> intended to solicit public comment. This document will be revised after this scientific review. This
> document does not predetermine any future agency decision under the Endangered Species Act."
>
> On Wed, Jan 11, 2017 at 12:03 PM, Shoemaker, Justin <justin_shoemaker@fws.gov> wrote:
>
> > Jim,
> >
> > Can you send the document to Dana? She will forward it along.
> >
> > Justin Shoemaker
> > Senior Listing Biologist
> > U.S. Fish and Wildlife Service, Region 6
> > 1511 47th Avenue, Moline, IL 61265
> > Phone: 309-757-5800 ext. 214
> > Email: justin_shoemaker@fws.gov
> >
> > ---------- Forwarded message ----------

From: **Jacobsen, Dana** <dana.jacobsen@sol.doi.gov>
Date: Wed, Jan 11, 2017 at 11:54 AM
Subject: Re: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report
To: "Shoemaker, Justin" <justin_shoemaker@fws.gov>

(b)(5) attorney client(b)(5) attorney client

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(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client

(b)(5) attorney

On Wed, Jan 11, 2017 at 8:41 AM, Shoemaker, Justin <justin_shoemaker@fws.gov> wrote:

> Dana,
>
> (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
> (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client
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> 1511 47th Avenue, Moline, IL 61265
> Phone: 309-757-5800 ext. 214
> Email: justin_shoemaker@fws.gov
>
> ---------- Forwarded message ----------
> From: **Bush, Jodi** <jodi_bush@fws.gov>
> Date: Wed, Jan 4, 2017 at 12:33 PM
> Subject: Re: Activity in Case 9:13-cv-00057-DWM Friends of the Wild Swan et al v. Ashe et al Status Report
> To: "Allan, Nathan" <nathan_allan@fws.gov>
> Cc: "Bell, Heather" <heather_bell@fws.gov>, "Zelenak, Jim" <jim_zelenak@fws.gov>, "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Mary Parkin <mary_parkin@fws.gov>
>
> I like it. Thanks! JB
>
> Jodi L. Bush

Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Wed, Jan 4, 2017 at 10:10 AM, Allan, Nathan <nathan_allan@fws.gov> wrote:

> I would suggest not releasing any draft documents until they are (at least) ready for peer review.
>
> I'd suggest putting something like this language in bold in a big grey box on the second page of the draft ssa report that goes out for peer/partner review.
>
> > **Note about this draft document, date, 2017**
> >
> > **This is a preliminary draft document of the U.S. Fish and Wildlife Service. This draft species status assessment report has not undergone peer review, and it should not be cited or referenced as an agency document. At this time it is intended for the sole purpose of soliciting scientific reviews from expert peer reviewers selected by the Service, from State and Federal partners with expert knowledge of the species and its habitat, and from internal reviewers by Department of Interior staff. The document is not intended to solicit public comment. This document will be revised after this scientific review. This document does not predetermine any future agency decision under the Endangered Species Act. For more information contact *first_last@fws.gov*.**
>
> I have not had this exact language reviewed by anyone, so we should do that and standardize it for all draft SSA reports. Thanks, Nathan
>
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>
> > Some Notes from my conversation. I have cc'd Nathan so he can better explain his thinking and can perhaps work on some language to include in the draft SSA as it goes to Peer Review (and other "public")
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> >
> > Heather Bell
> > Ecological Services HQ
> > Division of Restoration and Recovery
> > SSA Framework Team Lead

Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the Recovery Planning and Implementation (RPI) Google Site: https://sites.google.com/a/fws.gov/recovery-planning-and-implementation/ For audiences outside FWS visit http://www.fws.gov/endangered/improving_ESA/SSA html.

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Jodi has some concerns, below, about whether it is a deliberative document and whether providing plaintiffs/public with the draft SSA report would set a precedent that we don't maybe want to set.

Please provide your input/response and reply all so Dana and Jodi can consider.

Thanks,

Jim

On Tue, Jan 3, 2017 at 4:50 PM, Jodi Bush <jodi_bush@fws.gov> wrote:

(b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP (b)(5) AC&DPP Jim can you check with Heather/Mary? JB

Sent from my iPhone

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To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>

Hi Dana:

See below. (b)(5) DPP (b)(5) DPP (b)(5) DPP (b)(5) DPP (b)(5) DPP (b)(5) DPP (b)(5) DPP

Travis Annatoyn, Trial Attorney

United States Department of Justice

Environment and Natural Resources Division

601 D St. NW

Washington, D.C. 20004

travis.annatoyn@usdoj.gov

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WARNING: CASE CLOSED on 07/09/2014
Document Number: 50

Docket Text:
STATUS REPORT *Recovery Planning For The Canada Lynx* by Daniel Ashe, S.M.R. Jewell, U.S. Fish and Wildlife Service, United States Department of the Interior. (Annatoyn, Travis)

9:13-cv-00057-DWM Notice has been electronically mailed to:

John R. Mellgren mellgren@westernlaw.org

Matthew Kellogg Bishop bishop@westernlaw.org

Travis J. Annatoyn travis.annatoyn@usdoj.gov, efile_wmrs.enrd@usdoj.gov

9:13-cv-00057-DWM Notice has been delivered by other means to:

The following document(s) are associated with this transaction:

Document description: Main Document
Original filename:n/a
Electronic document Stamp:
[STAMP dcecfStamp_ID=1105468959 [Date=12/30/2016] [FileNumber=1800549-0] [12fb6f15daa45ca8a943948f20ea7edbf223bff8cd1c5aa98ad7685995b396612252110215c4521796313b62177db48dfc8ab1c90b01327962edff68ccedec8e]]

--
Dana Jacobsen
Assistant Regional Solicitor
Rocky Mountain Regional Office
Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Nathan Allan
U.S. Fish and Wildlife Service
Region 2, RO-Ecological Services, Decision Support Division
10711 Burnet Road, Suite 200, Austin, Texas 78758
(512) 490-0057 x237
Check out the SSA!

--
Dana Jacobsen
Assistant Regional Solicitor
Rocky Mountain Regional Office
Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

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Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Mogadam, Roya
To:	Stephanie Potter
Subject:	Re: 066174 - Cottonwood decision and FWS involvement following decision, Daines/Tester bill draft and any admin position
Date:	Thursday, July 27, 2017 4:01:32 PM

Can you add them to the invite but also send them the call in info?

On Thu, Jul 27, 2017 at 4:00 PM, Stephanie Potter <stephanie_potter@fws.gov> wrote:

> Hi all,
>
> I'm not sure what you need from me but I'm happy to assist tomorrow morning, or feel free to forward the meeting to anyone you need to add.
>
> Kind regards,
>
> Stephanie.
>
> **From:** Mogadam, Roya [mailto:roya_mogadam@fws.gov]
> **Sent:** Thursday, July 27, 2017 3:31 PM
> **To:** Marjorie Nelson
> **Cc:** Berglund, Jeff; Thomas Olenicki; Stephanie Potter
> **Subject:** Re: 066174 - Cottonwood decision and FWS involvement following decision, Daines/Tester bill draft and any admin position
>
> Adding Stephanie
>
> On Thu, Jul 27, 2017 at 3:19 PM, Marjorie Nelson <marjorie_nelson@fws.gov> wrote:
>
> Thanks Jeff and Tom. I CC'd Roya so she knows.
>
> Sent from my iPhone
>
> (720) 582-3524
>
> On Jul 27, 2017, at 2:54 PM, Berglund, Jeff <jeff_berglund@fws.gov> wrote:
>
> > Hi Marj - also just a final reminder that Tom is willing to participate in a call tomorrow if needed, but will be out of the office and without access to email. So if there's any way to let him know the details today that would be ideal, but if

not, then he'll need to be contacted via phone (406-449-5225 ext 213 will forward to him). I'll be out of the office and incommunicado. Thanks!

Jeff

---------- Forwarded message ----------
From: **Berglund, Jeff** <jeff_berglund@fws.gov>
Date: Thu, Jul 27, 2017 at 9:31 AM
Subject: Re: FW: 066174 - Cottonwood decision and FWS involvement following decision, Daines/Tester bill draft and any admin position
To: "Williams-shuck, Kathryn" <kate.williams-shuck@sol.doi.gov>
Cc: "Nelson, Marjorie" <marjorie_nelson@fws.gov>, Thomas Olenicki <thomas_olenicki@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>

Ex 5 Attorney Client

Jeff

On Thu, Jul 27, 2017 at 8:46 AM, Williams-shuck, Kathryn <kate.williams-shuck@sol.doi.gov> wrote:

Hi Marj-

Ex 5 Attorney Client

Thanks,

Kate

Kate Williams-Shuck

Attorney-Advisor

U.S. Department of the Interior

Rocky Mountain Regional Solicitor's Office

755 Parfet Street, Suite 151

Lakewood, CO 80215

Main: 303.445.0600

Direct: 303.445.0597 *** new phone numbers ***

Cell: 303.842.5877

kate.williams-shuck@sol.doi.gov

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On Wed, Jul 26, 2017 at 10:05 AM, Nelson, Marjorie <marjorie_nelson@fws.gov> wrote:

Kate - would you give this a quick look?

thanks

Marj

Marjorie Nelson

Chief, Division of Ecological Services

Mountain-Prairie Region
U.S. Fish and Wildlife Service

DIFFERENT NUMBER UNTIL 6TH FLOOR FIXED

720-582-3524

---------- Forwarded message ----------
From: **Berglund, Jeff** <jeff_berglund@fws.gov>
Date: Tue, Jul 25, 2017 at 4:29 PM
Subject: Re: FW: 066174 - Cottonwood decision and FWS involvement following decision, Daines/Tester bill draft and any admin position
To: "Nelson, Marjorie" <marjorie_nelson@fws.gov>
Cc: Maria Boroja <maria_boroja@fws.gov>, Jodi Bush <Jodi_Bush@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Thomas Olenicki <thomas_olenicki@fws.gov>

Hi Marj. So Jim, Tom, and I took another run at this and tried to provide some additional clarification per your comments and questions without overstepping our knowledge limitations. Again, it would be great to have Kate give it a quick look, since our staff most familiar with Cottonwood are out. I attached the surname and NTR docs also - let me know if those need any additional adjustments. Again, Tom has made himself available for a call on Friday if needed. Thanks!

Jeff

On Tue, Jul 25, 2017 at 11:46 AM, Nelson, Marjorie <marjorie_nelson@fws.gov> wrote:

> Hi Jeff,
>
> I made some comments/edits. Please let me know if they're incorrect or otherwise don't work.
>
> thanks,
>
> Marj
>
> Marjorie Nelson
>
> Chief, Division of Ecological Services
>
> Mountain-Prairie Region
> U.S. Fish and Wildlife Service
>
> DIFFERENT NUMBER UNTIL 6TH FLOOR FIXED
>
> 720-582-3524
>
> On Tue, Jul 25, 2017 at 9:53 AM, Berglund, Jeff <jeff_berglund@fws.gov> wrote:
>
> Hi Maria and Marjorie. The requested draft BP is attached. It so happens that our resident two experts on this issue (Jodi Bush and Katrina Dixon) are both out for the week and unreachable, so Tom Olenicki, Jim Zelenak and I did the best we could. Jim Zelenak (working on lynx CH) suggested that the BP be given a once-over by Kate Williams-Shuck in the SOL office, as she's apparently been working on this issue with Katrina - so you may want to consider that. Maria mentioned yesterday that you folks would take care of coordination with EA from this point, so thank you. Finally, I'll be

unavailable on Friday, but Tom Olenicki has graciously volunteered to participate in a phone call to represent the MT FO if needed. Please just let Tom know directly (406-449-5225, ext. 213) about any call details. Thanks for your assistance!

Jeff

---------- Forwarded message ----------
From: **Annette Naylon** <annette_naylon@fws.gov>
Date: Mon, Jul 24, 2017 at 10:48 AM
Subject: FW: 066174 - Cottonwood decision and FWS involvement following decision, Daines/Tester bill draft and any admin position
To: Jeff Berglund <jeff_berglund@fws.gov>

ES working with EA should draft BP for RD on Cottonwood, due 7/28 before meeting. EA provide Daines/Tester bill draft and any admin position on bill before meeting as well as next steps to follow Congressional visits.

_____

From: Nelson, Marjorie [mailto:marjorie_nelson@fws.gov]
Sent: Monday, July 24, 2017 10:45 AM
To: Annette Naylon
Cc: Kevin Shelley; Maria Boroja
Subject: Re: FW: 066174 - Cottonwood decision and FWS involvement following decision, Daines/Tester bill draft and any admin position

This would go to MT - Jeff Berglund is acting this week.
Marj

-----Original Message-----
From: annette_naylon@fws.gov [mailto:annette_naylon@fws.gov]
Sent: Monday, July 24, 2017 10:27 AM
To: annette_naylon@fws.gov
Subject: DCN: 066174 - Cottonwood decision and FWS involvement following
decision, Daines/Tester bill draft and any admin position

ES working with EA should draft BP for RD on Cottonwood, due 7/28 before meeting. EA provide Daines/Tester bill draft and any admin position on bill before meeting as well as next steps to follow Congressional visits.

> --
>
> Jeff Berglund
>
> Fish and Wildlife Biologist
>
> U.S. Fish and Wildlife Service
>
> Montana Field Office
>
> 585 Shepard Way, Suite 1
>
> Helena, MT 59601
>
> (406) 449-5225, ext. 206

--

Jeff Berglund

Fish and Wildlife Biologist

U.S. Fish and Wildlife Service

Montana Field Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225, ext. 206

--

Jeff Berglund

Fish and Wildlife Biologist

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--

Jeff Berglund

Fish and Wildlife Biologist

U.S. Fish and Wildlife Service

Montana Field Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225, ext. 206

--

Roya Mogadam

Deputy Assistant Regional Director, External Affairs

Mountain-Prairie Region

U.S. Fish and Wildlife Service

134 Union Boulevard

Lakewood, CO 80228

Roya_Mogadam@fws.gov

(303) 236-4572

--
Roya Mogadam
Deputy Assistant Regional Director, External Affairs
Mountain-Prairie Region
U.S. Fish and Wildlife Service
134 Union Boulevard
Lakewood, CO 80228

Roya_Mogadam@fws.gov
(303) 236-4572

From: Nelson, Marjorie
To: Bush, Jodi
Cc: Michael Thabault; Justin Shoemaker; Jim Zelenak
Subject: Re: LYNX and a draft summary of the Great Lakes wolf case
Date: Wednesday, August 23, 2017 10:40:05 AM

First blush (aka, not given it deep thought) is that it's a different because we are looking at the whole DPS and whether the whole DPS meets the definition of T or E.

However, I need to read the stuff about historic range. However, from Ben's summary, my first blush take is that we are okay here too.

It seems we should catch up on carnivores, especially given this case and the Cabinet Yak case. Should we set up a call?

Marj

Marjorie Nelson
Chief, Division of Ecological Services
Mountain-Prairie Region
U.S. Fish and Wildlife Service
DIFFERENT NUMBER UNTIL 6TH FLOOR FIXED
720-582-3524

On Wed, Aug 23, 2017 at 9:38 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Folks. Wondering if you all have given any thoughts to what this decision might mean in regards to our recommendation to delist for lynx?
>
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>
> Maybe this isn't something we need to worry about now but it seems to me if we do a credible job addressing these issues in the SSA, it can only help our future processes. And I think we have addressed them to a point BUT I am not sure we have gone far enough.
>
> Anyway something to think about as we go forward. JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Wed, Aug 23, 2017 at 8:52 AM, Cooley, Hilary <hilary_cooley@fws.gov> wrote:
>
> > ---------- Forwarded message ----------
> > From: **Powell, Tyson** <tyson.powell@sol.doi.gov>
> > Date: Wed, Aug 23, 2017 at 8:45 AM

Subject: Fwd: A draft summary of the wolf case
To: Hilary Cooley <hilary_cooley@fws.gov>
Cc: "Jesup, Benjamin" <benjamin.jesup@sol.doi.gov>, Jennifer Fortin-Noreus <jennifer_fortin-noreus@fws.gov>, Dana Jacobsen <dana.jacobsen@sol.doi.gov>

Hilary:

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Tyson

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Ben

--

Ben Jesup
Assistant Solicitor for Fish and Wildlife
Solicitor's Office
Department of the Interior
202-208-3170

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--
Tyson Powell
Office of the Regional Solicitor
Rocky Mountain Region
U.S. Department of Interior
755 Parfet Street, Suite 151
Lakewood, CO 80215
New telephone number: 303-445-0629

From: Zelenak, Jim
To: Mark McCollough
Subject: ssa question
Date: Wednesday, September 06, 2017 1:38:54 PM

In section 3.2.1, we said:

"This program has resulted in the release of 98 lynx from 2000 to 2015 (10 lynx died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine (MDIFW 2014a, p. 75)."

You commented: "If you want to update, the sentence would read: This program has resulted in the release of 106 lynx from 2000 to 2016 (12 lynx died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine."

I'd like to make the update, but also need an updated citation for what Anna commented would be the 2016 Annual Report.

Would that just be "(MDIFW 2016, p. XX)" If so, could you reply with the page number(s) and also add that full citation to the list you are working on?

Thanks.

(b) (5) attorney client(b) (5) attorney client(b) (5) attorney client(b) (5) attorney client
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Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Zelenak, Jim
Subject: Re: Lynx call today
Date: Tuesday, October 17, 2017 11:51:08 AM

---

ok, thanks. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Tue, Oct 17, 2017 at 11:17 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Justin and I spoke on the phone earlier an (b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client I mentioned that Kat is most familiar here with those issues and might be able to join the call if questions might arise that she could help with, and he supported that.
>
> I asked Kat and she said she could sit in.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

From:	Nelson, Marjorie
To:	Maricela Constantino
Cc:	Jodi Bush; Justin Shoemaker/R6/FWS/DOI
Subject:	Fwd: lynx 5 YSR
Date:	Thursday, November 16, 2017 3:03:54 PM

Maricela,
What do you need to move this to Gary? We sent up the BP on the 5 YSR. As we move the 4(f) letter through to Noreen then the Director's office, how should we move that to Gary?
thanks,
Marj

Marjorie Nelson
Chief, Division of Ecological Services
Mountain-Prairie Region
U.S. Fish and Wildlife Service
303-236-4258 direct
720-582-3524 cell

---------- Forwarded message ----------
From: **Williams-shuck, Kathryn** <kate.williams-shuck@sol.doi.gov>
Date: Thu, Nov 16, 2017 at 1:30 PM
Subject: Re: lynx 5 YSR
To: "Constantino, Maricela" <maricela_constantino@fws.gov>
Cc: "Shoemaker, Justin" <justin_shoemaker@fws.gov>, "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>, Marjorie Nelson <marjorie_nelson@fws.gov>

Hi Justin-

Dana and I will have comments but I am also circulating to SOL-DC. At the very least I will send you my comments by tomorrow so that you have those before I go on leave next week.

Thanks,
Kate

Kate Williams-Shuck
Attorney-Advisor
U.S. Department of the Interior
Rocky Mountain Regional Solicitor's Office
755 Parfet Street, Suite 151
Lakewood, CO 80215
Main: 303.445.0600
Direct: 303.445.0597 *** new phone numbers ***
Cell: 303.842.5877
kate.williams-shuck@sol.doi.gov

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On Wed, Nov 15, 2017 at 4:17 PM, Constantino, Maricela <maricela_constantino@fws.gov> wrote:

> Justin,
> Nicely done. Attached are a few comments. Given the high profile of this species, the associated court-order, and the fact that we don't issue 4(f) memo's often I had assumed at minimum that DOI-SOL would also have interest in reviewing (totally a guess). I suppose this is more of a question for Dana. [redacted] I recommend having the RO check in with Gary Frazer our AD to determine the necessary review.
>
> **********
> Maricela Constantino
> Branch of Recovery and State Grants
> Ecological Services
> US Fish and Wildlife Service - Headquarters Office
>
> maricela_constantino@fws.gov
> 703/358-2113 office
>
> On Wed, Nov 15, 2017 at 2:26 PM, Shoemaker, Justin <justin_shoemaker@fws.gov> wrote:
>
> > Dana and Kate,
> >
> > [redacted]
> >
> > Thanks.
> >
> > Justin Shoemaker
> > Classification and Recovery Biologist
> > U.S. Fish and Wildlife Service, Region 6
> > Phone: 309-757-5800 x214
> > Email: justin_shoemaker@fws.gov
> >
> > On Wed, Nov 15, 2017 at 11:57 AM, Jacobsen, Dana <dana.jacobsen@sol.doi.gov> wrote:
> >
> > > Hi all,
> > >
> > > [redacted]

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Dana

---------- Forwarded message ----------
From: **Annatoyn, Travis (ENRD)** <Travis.Annatoyn@usdoj.gov>
Date: Wed, Nov 15, 2017 at 10:11 AM
Subject: RE: lynx 5 YSR
To: "Jacobsen, Dana" <dana.jacobsen@sol.doi.gov>

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Travis Annatoyn, Trial Attorney

United States Department of Justice

Environment and Natural Resources Division

601 D St. NW

Washington, D.C. 20004

travis.annatoyn@usdoj.gov

Tel: 202-514-5243

Fax: 202-305-0275

--

Dana Jacobsen
Assistant Regional Solicitor
Rocky Mountain Regional Office
Office of the Solicitor
755 Parfet, Suite 151
Lakewood, CO 80215
(303) 445-0639******NOTE THIS IS A NEW PHONE NUMBER

From:	Shoemaker, Justin
To:	Zelenak, Jim
Cc:	Jodi Bush; Marjorie Nelson
Subject:	Re: DRAFT Lynx Update to the Court
Date:	Tuesday, December 05, 2017 12:51:44 PM
Attachments:	2017 12 01 DOJ Draft WILDLIFE-#298505-v1-_Lynx_RP__7_17_Status_Report_CLEAN_JS.doc

---

My comments are attached.

Justin Shoemaker
Classification and Recovery Biologist
U.S. Fish and Wildlife Service, Region 6
Phone: 309-757-5800 x214
Email: justin_shoemaker@fws.gov

On Thu, Nov 30, 2017 at 4:28 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Although I'm a little out of the loop with what's going on with the 4(f)(1) and the RSOL's/HQ's review of the final SSA report and the 5-year review, we do have a 6-month update to the court due by the end of December. Given the above and the upcoming holiday, I've drafted the attached update based on my understanding of how things may unfold, using the last court update as a template.
>
> Because of my uncertainty about this process, I thought I'd run this by you three before sending a draft to Dana.
>
> Please edit as you see fit in TRACK CHANGES and send me your thoughts/concerns at your earliest convenience so I can get a draft to Dana allowing plenty of time for her to coordinate with DOJ and get the final update to the court by the Dec. 31 deadline.
>
> Also wanted to let you know that I will be on annual leave after Christmas, returning to the office on Jan. 15 - the same day, coincidentally, that our determination (or formal recovery plan) is due to the court...
>
> Cheers!
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

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From:	Thabault, Michael
To:	Jacobsen, Dana; Annatoyn, Travis (ENRD); Kathryn Williams-shuck
Cc:	Justin Shoemaker; Marjorie Nelson; Jodi Bush
Subject:	Lynx Materials
Date:	Wednesday, January 03, 2018 1:15:22 PM
Attachments:	2017 12 22 FINAL Lynx SSA Report.pdf Canada Lynx 5YR_with RD signature.pdf 0617_001.pdf

---

Counselors, attached please find the final SSA, signed 5-yr review and the signed 4(f) memo. (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client Thanks let me know if there is anything else to do. Thanks.

Michael Thabault
Assistant Regional Director
Ecological Services
U.S. Fish and Wildlife Service
Mountain Prairie Region
303-236-4210
michael_thabault@fws.gov

---------- Forwarded message ----------
From: **Shoemaker, Justin** <justin_shoemaker@fws.gov>
Date: Wed, Jan 3, 2018 at 12:22 PM
Subject: Re: Attached Image
To: "Thabault, Michael" <michael_thabault@fws.gov>
Cc: Marjorie Nelson <marjorie_nelson@fws.gov>, Jodi Bush <Jodi_Bush@fws.gov>

Mike,

Here's the Final SSA Report and signed final 5-yr review.

Justin Shoemaker
Classification and Recovery Biologist
U.S. Fish and Wildlife Service, Region 6
Phone: 309-757-5800 x214
Email: justin_shoemaker@fws.gov

On Wed, Jan 3, 2018 at 12:59 PM, Thabault, Michael <michael_thabault@fws.gov> wrote:

> Justin, OK here is the entire memo. Can I get the Final SSA and the final 5-yr review to send to DoJ and Sol?
>
> Michael Thabault
> Assistant Regional Director
> Ecological Services
> U.S. Fish and Wildlife Service

Mountain Prairie Region
303-236-4210
michael_thabault@fws.gov

---------- Forwarded message ----------
From: <FW6Scan2Email@fws.gov>
Date: 2018-01-03 12:51 GMT-07:00
Subject: Attached Image
To: "michael_thabault@fws.gov" <michael_thabault@fws.gov>

From: Thabault, Michael
To: Annatoyn, Travis (ENRD)
Cc: Jacobsen, Dana; Kathryn Williams-shuck; Justin Shoemaker; Marjorie Nelson; Jodi Bush
Subject: Re: Lynx Materials
Date: Wednesday, January 03, 2018 1:45:31 PM

Will do. [redacted]

Michael Thabault
Assistant Regional Director
Ecological Services
U.S. Fish and Wildlife Service
Mountain Prairie Region
303-236-4210
michael_thabault@fws.gov

On Wed, Jan 3, 2018 at 1:39 PM, Annatoyn, Travis (ENRD) <Travis.Annatoyn@usdoj.gov> wrote:

> [redacted]
>
> [redacted]
>
> [redacted]
>

Tel: 202-514-5243

Fax: 202-305-0275

From: Thabault, Michael [mailto:michael_thabault@fws.gov]
Sent: Wednesday, January 03, 2018 3:15 PM
To: Jacobsen, Dana <Dana.Jacobsen@sol.doi.gov>; Annatoyn, Travis (ENRD) <TAnnatoyn@ENRD.USDOJ.GOV>; Kathryn Williams-shuck <kate.williams-shuck@sol.doi.gov>
Cc: Justin Shoemaker <justin_shoemaker@fws.gov>; Marjorie Nelson <marjorie_nelson@fws.gov>; Jodi Bush <Jodi_Bush@fws.gov>
Subject: Lynx Materials

Counselors, attached please find the final SSA, signed 5-yr review and the signed 4(f) memo. (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client(b)(5) attorney client(b)(5) attorney client (b)(5) attorney client(b)(5) attorney client Thanks let me know if there is anything else to do. Thanks.

Michael Thabault

Assistant Regional Director

Ecological Services

U.S. Fish and Wildlife Service

Mountain Prairie Region

303-236-4210

michael_thabault@fws.gov

---------- Forwarded message ----------
From: **Shoemaker, Justin** <justin_shoemaker@fws.gov>
Date: Wed, Jan 3, 2018 at 12:22 PM
Subject: Re: Attached Image
To: "Thabault, Michael" <michael_thabault@fws.gov>
Cc: Marjorie Nelson <marjorie_nelson@fws.gov>, Jodi Bush <Jodi_Bush@fws.gov>

Mike,

Here's the Final SSA Report and signed final 5-yr review.

Justin Shoemaker

Classification and Recovery Biologist

U.S. Fish and Wildlife Service, Region 6

Phone: 309-757-5800 x214

Email: justin_shoemaker@fws.gov

On Wed, Jan 3, 2018 at 12:59 PM, Thabault, Michael <michael_thabault@fws.gov> wrote:

> Justin, OK here is the entire memo. Can I get the Final SSA and the final 5-yr review to send to DoJ and Sol?
>
> Michael Thabault
>
> Assistant Regional Director
>
> Ecological Services
>
> U.S. Fish and Wildlife Service
>
> Mountain Prairie Region
>
> 303-236-4210
>
> michael_thabault@fws.gov
>
> ---------- Forwarded message ----------
> From: <FW6Scan2Email@fws.gov>
> Date: 2018-01-03 12:51 GMT-07:00
> Subject: Attached Image
> To: "michael_thabault@fws.gov" <michael_thabault@fws.gov>

From:	sjackson03@fs.fed.us
To:	anne_vandehey@fws.gov; blbarrera@fs.fed.us; (b) (6) P.I.I. ; bryon_holt@fws.gov; scatton@fs.fed.us; sjackson03@fs.fed.us; ljacobson@fs.fed.us; jrsparks@blm.gov; jim_zelenak@fws.gov; kurt_broderdorp@fws.gov; mark_mccollough@fws.gov; petermcdonald@fs.fed.us; Mike_Wrigley@nps.gov; (b) (6) P.I.I. ; rhnaney@fs.fed.us; Rick_Kahn@nps.gov; Shawn_Sartorius@fws.gov; kswisher@fs.fed.us; Tamara_Smith@fws.gov
Subject:	Lynx Bio-Team conf call
Date:	Wednesday, September 12, 2012 1:00:25 PM

Hi Group,

The Lynx Bio-Team will be having a conference call from **9:00 am – 1:00 pm (MDT) on Thursday, September 27th**. Please have your edits and comments related to the revised LCAS submitted to Nancy Warren and Bob Naney (using Track Changes) by the 21st so that this call can be used to discuss and resolve any remaining concerns. This is the time to look at the full document in detail, but please focus particular attention on Chapter 5 (Conservation Strategy). You should already have received a copy of the draft revision, but I've also included it here. Once the Bio-Team has completed our review, the Steering Committee will be briefed (they will be meeting in late October/early November).

For the call on Sept. 27th, please use the following call-in information:

Call-In Number: (b) (5) CIP

Access Code: (b) (5) CIP

It is great to be getting to this point and I'm looking forward to hearing you all on the 27th. Thank you for your continued commitment to lynx conservation.

Scott Jackson

National Carnivore Program Leader
US Forest Service
PO Box 7669
Missoula, Montana 59807
406-329-3664
sjackson03@fs.fed.us

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please notify the sender and delete the email immediately. [attachment "lcas_revision_30Aug2012.docx" deleted by Jim Zelenak/R6/FWS/DOI]

From: Dixon, Michael
To: Bridget Fahey; Justin Shoemaker; Sarah Fierce; Shawn Sartorius; Anne Vandehey; Brent Esmoil; Jodi Bush
Subject: Re: Lynx recovery planning call - week of April 8
Date: Friday, April 05, 2013 11:12:19 AM

Looks like 10AM Tuesday (April 9) works for enough people. Let's plan for a call then.

Conference line: (b) (5) CIP
Participant #: (b) (5) CIP

Talk to you soon.

Mike

/|\^._.^/|\ /|\^._.^/|\ /|\^._.^/|\

Mike Dixon, Ph.D.
Regional Recovery Coordinator &
Deputy Regional ESA Chief (Acting)
U.S. Fish & Wildlife Service
Division of Endangered Species
134 Union Boulevard
Lakewood, CO 80226
(303) 236-4257
Veritas vincit

On Tue, Apr 2, 2013 at 2:49 PM, Dixon, Michael <michael_d_dixon@fws.gov> wrote:

> Hello all,
> One of the tasks Seth Willey left with me prior to departing on his detail to the beautiful San Francisco Bay NWR Complex was an assignment from the RD to "Make a recommendation on lynx recovery planning issues by May 1". I had a good discussion about this with Jim Z. this afternoon, and he agreed that we should do a call with the broader range of folks involved lynx ESA issues in R6.
>
> As you all know, the primary threat that triggered listing was inadequate Forest Plans that did not meet lynx needs. As most of these plans have been completed or amended, we could, in theory, move to delist the lynx, which would negate the pressing need for development of a recovery plan. However, since listing, climate change has been raised as a concern for the species.
>
> So I propose that we find a time to meet (hopefully next week) to discuss people's thoughts on whether we should:
>
> 1) Start a recovery plan; or
> 2) Start a 5 yr status review to determine whether climate change or other threats impact our ability to delist the species; or
> 3) Some other option that we agree is appropriate
>
> Please complete the poll at the link below as soon as convenient.
> http://www.doodle.com/bwigxi9tkd29yqx2

Thanks!

Mike

/|\^._.^/|\ /|\^._.^/|\ /|\^._.^/|

Mike Dixon, Ph.D.
Regional Recovery Coordinator &
Deputy Regional ESA Chief (Acting)
U.S. Fish & Wildlife Service
Division of Endangered Species
134 Union Boulevard
Lakewood, CO 80226
(303) 236-4257
Veritas vincit

From:	Jackson, Scott -FS
To:	bryon_holt@fws.gov; Catton, Susan J -FS; Jackson, Scott -FS; Jacobson, Lee -FS; jrsparks@blm.gov; Jim Zelenak; kurt_broderdorp@fws.gov; Maes, Ronnie -FS; mark_mccollough@fws.gov; McDonald, Peter M -FS; mike_wrigley@nps.gov; Rohrer, John -FS; Swisher, Kristi -FS; Tamara_Smith@fws.gov
Cc:	Plunkett, Steven R -FS
Subject:	lynx bio-team call 9/27
Date:	Tuesday, September 17, 2013 5:32:56 PM

Hello Team,

Thanks for responding to the recent doodle poll. I really appreciate the fact that everyone responded. And, thanks to your flexibility, it looks like we actually have a date that will work for the ENTIRE team (a very rare event!).

So, I'd like to schedule our Lynx Bio-Team call for **Friday, Sept. 27 10:00 am – 12:00 pm, MDT**. Please use the call-in information below. I will soon provide you with further information for your review as a basis for some of our group discussion during the call. Basically, there are some things in Chapter 5 (Conservation Strategy) of the revised LCAS (I believe Nancy Warren sent you all a copy of the final draft in mid-August) that I'd like to discuss. So, if you have a few minutes, please review the conservation measures. I'll send you more specifics soon.

Call-in Number: (b) (5) CIP

Access Code: (b) (5) CIP

Thanks again. I look forward to our call. Have a good week!

Scott Jackson

National Carnivore Program Leader
US Forest Service
PO Box 7669
Missoula, Montana 59807
406-329-3664
sjackson03@fs.fed.us

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From: Phifer, Paul
To: Zicari, Laury; Karen Morey
Cc: Lowell Whitney; Mark McCollough; Spencer Simon; Martin Miller
Subject: Re: Lynx hcp tasks
Date: Wednesday, October 22, 2014 7:55:36 AM

How about we all get on the phone at 2pm to check in? (b) (5) CIP(b) (5) CIP

In discussing with Lowell, I believe we have a good plan from the state on mitigation. We are feeling comfortable that the mitigation as described in the ITP, in conjunction with the MOU, is sufficient. Let's discuss at 2pm.

Paul

Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Wed, Oct 22, 2014 at 8:32 AM, Zicari, Laury <laury_zicari@fws.gov> wrote:

> Paul -- Mark is on page 30 of the 40 in the biological opinion. He is also answering Spencer's questions about the chronology. What else does this office need to do, please?
>
> I have a "date" to talk to Meagan this afternoon about the outreach plan and we exchanged emails about the message needing to change -- we are not messaging that there is something to comment on -- the decision will be made, the plan will be implemented, what does that mean should be the message in my view. We will get that largely done this afternoon.
>
> I understand Mark was working on permit condition questions per Lowell's request.
>
> Are we squared away with the mitigation piece? It seemed to us in reviewing the draft MOU that the State didn't understand what they need to do -- it is not just cutting 6000 acres -- it is offsetting take by creating and maintaining that much HQHH. And they said something that leads us to think maybe it might already be there without any treatments -- that is, 36% of trees "mid successional" soft wood.
>
> We would like to know about the software Lowell just purchased and need to get help for our FOIA and future paperwork associated with this project, before he goes to Alaska please.
>
> I have training this morning; back in the office at 1:30. I also have to work on a schedule for the salmon recovery plan in prep for a meeting with NOAA and Peter Lamothe tomorrow.
>
> On Tue, Oct 21, 2014 at 9:07 PM, Phifer, Paul <paul_phifer@fws.gov> wrote:
>
> > Folks - where do we stand on some of these issues? I hear that we won't get the final MOU until Thursday. We need this document for the final package, so it

doesn't seem like we can make a permit decision until Friday. What's the status of the BO? The permit was sent to the state for their review today. I am working on the NEPA stuff and will get back to Lowell ASAP. Marty and I were tied up in an NEC meeting all day today. I know he will be working on the findings doc tomorrow.

Thanks, Paul

_____
Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Mon, Oct 20, 2014 at 2:44 PM, Phifer, Paul <paul_phifer@fws.gov> wrote:

> Sorry, I am getting this out late. Last week, we discussed -
>
> 1) Ask Dave to review permit - we did and he can't
> 2) Mark and Anne prioritize BO and get to Paul by COB Tuesday
> 3) Spencer review permit and get to Paul by COB Tuesday
> 4) Lowell get Paul EA, FONSI and RTC by COB Tuesday - he already sent me the EA and FONSI. Is the RTC part of what you sent me?
> 5) FO is reviewing outreach materials and need their review and final copy by COB Tuesday
> 6) Marty is working on the FOIA
> 7) Marty is finalizing the findings doc and will get to Paul by COB Tuesday
>
> Do we have the ITP yet from the State? If not, I will ask Jim Connolly who is here now.
>
> Thanks, Paul
>
> _____
> Paul Phifer, PhD
> Assistant Regional Director - Ecological Services
> Northeast Region
> Dept of the Interior
> US Fish and Wildlife Service
> 413.253.8698 work
> 413.687.4764 cell

--

Laury Zicari
Field Supervisor
Maine Field Office
17 Godfrey Drive, Suite 2
Orono, ME 04473
207-866-3344 x 111
Fax 866-3351
Cell 207-949-0561

From:	Ryan Moehring
To:	Rob Chaney
Cc:	Jim Zelenak
Subject:	RE: Lynx Questions
Date:	Thursday, January 15, 2015 2:38:52 PM

Sounds good. We'll do that. Thanks, Rob. -Ryan

From: Rob Chaney [mailto:Rob.Chaney@missoulian.com]
Sent: Thursday, January 15, 2015 2:22 PM
To: Ryan Moehring
Subject: RE: Lynx Questions

That's fine – I'd just like to get together before noon than after so I have time to write.
Do you want to call me when everyone's at hand?
Rob

From: Ryan Moehring [mailto:ryan_moehring@fws.gov]
Sent: Thursday, January 15, 2015 1:33 PM
To: Jim Zelenak
Cc: Rob Chaney
Subject: RE: Lynx Questions

Rob,

Any chance we can push it to 11:15 or 11:30 to be sure Jim is able to join us for the entirety of our call?

Thanks,

-Ryan

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Thursday, January 15, 2015 12:34 PM
To: Ryan Moehring
Subject: Re: Lynx Questions

I think/hope the 10 AM conf. call for Sprague's pipit (which my FS has asked me to sit in on) will be over by 11. If that call goes long, I'll call in as soon as I am able.

On Thu, Jan 15, 2015 at 12:14 PM, Ryan Moehring <ryan_moehring@fws.gov> wrote:
Thanks, Rob. Since Jim and I are in different locations, perhaps a conference line would work best. We can use mine:

Number: (b) (5) CIP, passcode: (b) (5) CIP

Looking forward to it,

-Ryan

From: Rob Chaney [mailto:Rob.Chaney@missoulian.com]

Sent: Thursday, January 15, 2015 12:11 PM
To: Ryan Moehring
Subject: RE: Lynx Questions

Thanks Ryan,
Friday at 11 Mountain time would be fine, if that's still good for you.
You can reach me at 406-523-5382, or I can call you.
Looking forward to it,
Rob Chaney
Missoulian staff writer

From: Ryan Moehring [mailto:ryan_moehring@fws.gov]
Sent: Thursday, January 15, 2015 11:20 AM
To: Rob Chaney
Cc: Jim Zelenak
Subject: Lynx Questions

Hi Rob,

Thanks again for your interest in our lynx 5-Year Status Review. The person I'd like you to speak with is Jim Zelenak, who is our species lead for the region. Jim and I are available to speak with you over the phone tomorrow. 11, 12, 1, or 2 work for us. Can you make one of those times?

Thanks,
-Ryan

Ryan Moehring
Public Affairs Specialist (ND, SD, WY, MT)
Mountain-Prairie Region
U.S. Fish and Wildlife Service
303-236-0345
Ryan_Moehring@fws.gov

Facebook | Twitter | Flickr | YouTube

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Nicolaysen, Tara
To: Zelenak, Jim
Cc: Jodi Bush; Seth Willey; Justin Shoemaker; Heather Bell
Subject: Re: Lynx SSA Call
Date: Monday, March 02, 2015 11:40:23 AM
Attachments: SSA Core questions.docx

Here are the Core (aka cardinal) questions that might be a good starting place, in addition to IPS needs. These are on the SSA google site, but I downloaded for you :-)

Tara

On Thu, Feb 26, 2015 at 1:33 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> All:
>
> Thanks for responses to the poll. Looks like the time that works best for all is Monday, March 2, 11-12 Mountain Time.
>
> Call: (b) (5) CIP
> Participant Passcode: (b) (5)
>
> General agenda is to discuss how to apply SSA to inform the 5-year review and perhaps subsequent recovery plan for the multi-state, multi-region lynx DPS. I hope we can also discuss whether lynx might be added to the current 5 SSA projects slated for the SSA workshop in Lakewood April 29-30.
>
> Let me know if you have questions/concerns.
>
> Thanks,
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Tara Nicolaysen
Ecological Services
HQ Branch of Conservation Integration

remotely located in R6 RO
134 Union Blvd.

Lakewood, CO 80228

General work schedule: Work from home MWF, in office TTH
Cell number * is best number to reach me at for immediate contact:
303-902-7371* (cell)
303-236-4259 (office)
703-657-9585 (cell)

Check these out!

- SSA Framework - google site for staff: https://sites.google.com/a/fws.gov/ssa/
- REV google site for staff: https://sites.google.com/a/fws.gov/rev/

From: Zelenak, Jim
To: Parkin, Mary
Subject: Re: Setting up a lynx SSA call for this week
Date: Tuesday, May 05, 2015 1:35:06 PM

Here you go, Mary.

(b) (5) CIP

Participant Passcode: (b) (5)

Leader Passcode: (b) (5)

Let me know if you want to dial in as "leader" or if we should - my Field Supervisor, Jodi Bush, will be joining here.

Are we planning for an hour? Longer? Do you have an agenda? Or will we just play it by ear? I think Jodi has some questions about process, costs/contracts, time lines, etc. And we can certainly provide an update based on the call she and I had yesterday with Seth.

Let me know if there is anything else you need from me or from Jodi before the call.

Thanks,

Jim

On Tue, May 5, 2015 at 1:22 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Hi Jim,
>
> In checking my calendar, it looks like there may be a scheduling conflict with using our TE line. If you have a line that you know is available, that'd be great!
>
> Thanks,
> Mary
>
> On Mon, May 4, 2015 at 6:03 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Thanks Mary,
> >
> > Do you have call-in info? I have a line if we need - let me know.
> >
> > Jim
> >
> > On Mon, May 4, 2015 at 2:16 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:
> >
> > > Hi Seth et al.,
> > >
> > > In looking at the poll, I'm thinking that even though we're going to miss some valuable participants, we should go ahead and touch base on Thursday. The quorum would include Jim, Jonathan, Jennifer, and me, and I hope that others might find time to join. Whatever the case, let's keep the momentum going.
> > >
> > > Looking at time zones, could we confirm 11 am edt (10 am cdt/9 am mdt) this

Thursday? If so, I'll send out call-in info tomorrow.

Thanks,
Mary

On Mon, May 4, 2015 at 2:35 PM, Willey, Seth <seth_willey@fws.gov> wrote:

> After looking at the doodle poll options, you might want to go without me. What works for me does not work for others. Jim, Jodi and I will be discussing our plan today (similar to the conversation we had at the end of the SSA meeting last week, after Jim left), so Jim can carry the water from that conversation.
>
> Seth
>
> **********
> Seth L. Willey
> Assistant Regional ESA Chief &
> Regional Recovery Coordinator
> USFWS, Mountain-Prairie Region
> Seth_Willey@fws.gov
> 303-236-4257
> **********
>
> On Mon, May 4, 2015 at 12:28 PM, Willey, Seth <seth_willey@fws.gov> wrote:
>
> > My Thursday is crazy and I cannot do that time slot (9am mountain, thurs). I could do tomorrow afternoon (pretty open), Wed or Thur after 2 pm mountain, or most any time Friday.
> >
> > Seth
> >
> > **********
> > Seth L. Willey
> > Assistant Regional ESA Chief &
> > Regional Recovery Coordinator
> > USFWS, Mountain-Prairie Region
> > Seth_Willey@fws.gov
> > 303-236-4257
> > **********
> >
> > On Mon, May 4, 2015 at 11:20 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:
> >
> > > Checking the rapid feedback from you all (THNX!), it looks like our best bet is Thursday morning. I see this doesn't conform to your schedules, Dave and Heather, with apologies and hopes that you can serendipitously (??) join us.
> > >
> > > Let's try for a 11 am (EDT) call time this Thursday. If we need to move it forward or back, please suggest a better time and we'll take it from there.
> > >
> > > Cheers,
> > > Mary

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

--
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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
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--
Jim Zelenak, Biologist

U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Parkin, Mary
Cc: Jodi Bush; Seth Willey; David Smith; Jonathan Cummings; Jennifer Szymanski
Subject: Re: Just in case an invitation to tomorrow"s lynx SSA call didn"t reach you >>>
Date: Thursday, May 07, 2015 8:45:52 AM
Attachments: Lynx - IPS_2015 05 04.xlsx

I've attached a spreadsheet where I updated the time line under the "Tasks&Time" tab.

On Wed, May 6, 2015 at 6:05 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Hi all,
>
> Here's what I posted on the calendar, but I haven't received a confirmation that it's reached you, so:
>
> Call info is for 9 am MDT, 10 am CDT, and 11 am EDT:
>
> (b) (5) CIP
> Participant Passcode: (b) (5)
> Leader Passcode: (b) (5) CIP
>
> Jim, it'd be great if you'd dial in as leader. I've been flat out since Denver, so I hope this is enough notice for you all. Call agenda: (1) brief recap of last week's discussion, (2) next steps, and (3) participants/roles in moving forward. I'm assuming we all have Jennifer's products on hand -- if not, we can get them to you posthaste!
>
> Talk tomorrow,
> Mary
>
> --
> *Mary Parkin*
> *Endangered Species Recovery Coordinator, Northeast Region*
> *U.S. Fish and Wildlife Service, Hadley, MA*
> *Remotely located in Escalante, Utah:*
> *Mailing address PO Box 637, Escalante, UT 84726*
> *Street address 145 North Center St, Escalante, UT 84726*
> *Phone 617-417-3331*
> *Email mary_parkin@fws.gov*

--
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585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Parkin, Mary
Cc:	Jodi Bush; Seth Willey; David Smith; Jonathan Cummings; Jennifer Szymanski
Subject:	Re: Lynx SSA call tomorrow
Date:	Tuesday, May 12, 2015 10:08:23 AM

Yes - we can use the same number/passcode as last time. Thanks Mary.

(b) (5) CIP
participant code (b) (5)

On Tue, May 12, 2015 at 10:06 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Hi folks,
>
> Well, tomorrow, 5/13, from 1-2 pm MDT is the clear winner on the doodle poll. Jodi, if this time still works for you, that'd be great!
>
> I'll send out a Google invitation now. Jim, can we use your call-in info again? I'll include it on the invitation, but we can revert to my TE line if needed.
>
> Cheers,
> Mary
>
> --
> *Mary Parkin*
> *Endangered Species Recovery Coordinator, Northeast Region*
> *U.S. Fish and Wildlife Service, Hadley, MA*
> *Remotely located in Escalante, Utah:*
> *Mailing address PO Box 637, Escalante, UT 84726*
> *Street address 145 North Center St, Escalante, UT 84726*
> *Phone 617-417-3331*
> *Email mary_parkin@fws.gov*

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Parkin, Mary
Subject: Re: Accepted: Canada Lynx SSA Call @ Wed May 13, 2015 3pm - 4pm (mary_parkin@fws.gov)
Date: Tuesday, May 12, 2015 12:03:19 PM

Thanks, Mary. Talk to you tomorrow at 1 Mountain Time!

On Tue, May 12, 2015 at 11:21 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Jim, my Google calendar is set for eastern time, since I'm R5. Don't let the title of the email fool you!
> Cheers,
> Mary
>
> On Tue, May 12, 2015 at 1:17 PM, Jim Zelenak <jim_zelenak@fws.gov> wrote:
>
> **Jim Zelenak has accepted this invitation.**
>
> ## Canada Lynx SSA Call
>
> The objective of this call is to clearly "frame the assessment." The tentative agenda is:
>
> 1. Review options for the (a) project approach/schedule and (b) core SSA team (see attachment)
> 2. Identify the core team for SSA
> 3. Reach preliminary agreement on project approach/schedule
> 4. Review information needs and modeling options
> 5. Discuss additional participants in SSA process (experts, FWS decision makers, states, etc.) and how to structure their roles
>
> Your suggestions for changing or adding to this agenda are welcome! In terms of preparation, please have Jim's proposed project schedule on hand. I've also attached it for your convenience.
>
> | | |
> |---|---|
> | When | Wed May 13, 2015 3pm – 4pm Eastern Time |
> | Where | (b) (5) CIP , passcode: (b) (5) (map) |
> | Video call | https://plus.google.com/hangouts/_/doi.gov/mary |
> | Calendar | mary_parkin@fws.gov |
> | Who | • Mary Parkin - organizer
• David Smith
• Jennifer Szymanski
• Jonathan Cummings
• Jodi Bush
• Seth Willey
• Jim Zelenak |
> | Attachments | LOGISTICAL OPTIONS FOR LYNX SSA PROJECT PLAN.docx
Lynx_proposed project schedule_20150512.xlsx |
>
> Invitation from Google Calendar

You are receiving this email at the account mary_parkin@fws.gov because you are subscr bed for invitation replies on calendar mary_parkin@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
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Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Justin Shoemaker
Subject: Fwd: Webex info for lynx SSA call today, 1-2 pm MDT
Date: Wednesday, May 13, 2015 10:50:12 AM

---

1 PM Mountain Time.

---------- Forwarded message ----------
From: **Parkin, Mary** <mary_parkin@fws.gov>
Date: Wed, May 13, 2015 at 10:14 AM
Subject: Webex info for lynx SSA call today, 1-2 pm MDT
To: Heather Bell <heather_bell@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Jodi Bush <jodi_bush@fws.gov>, Seth Willey <Seth_Willey@fws.gov>, Jonathan Cummings <jwcummings@usgs.gov>

Hi again,

Heather has graciously consented to provide her webex connection for today's call. Hopefully this will allow us to be as efficient as possible, as both she and I can only allot an hour for the call.

So, full connection details:

Phone: (b) (5) CIP, passcode (b) (5) CIP

Instant Net Conference Details:

Meeting Number: (b) (5)

Meeting Passcode:

Meeting Host: HEATHER M BELL

Join Instructions for Instant Net Conference:

1. Join the meeting now:

(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP

If using Google Chrome, I suggest copying the link and pasting it into Explorer.

2. Enter the required fields.

3. Indicate that you have read the Privacy Policy.

4. Click on Proceed.

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Parkin, Mary
Cc:	Heather Bell; Jodi Bush; Seth Willey; Jonathan Cummings; Justin Shoemaker
Subject:	Re: Webex info for lynx SSA call today, 1-2 pm MDT
Date:	Wednesday, May 13, 2015 12:26:26 PM
Attachments:	2015 05 13 DRAFT Proj Plan Canada Lynx 5-YR TRACK.docx 2015 05 13 DRAFT Proj Plan Canada Lynx 5-YR Clean.docx

---

I've attached TRACK and CLEAN versions of the draft project plan after incorporating edits and responding to comments submitted on the 5-5 draft. We received substantive comments from R5 (thanks Mary) and from Jennifer (thanks Jennifer); we received minor comments from WAFO, N.IDFO, and MNFO.

On Wed, May 13, 2015 at 10:14 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Hi again,
>
> Heather has graciously consented to provide her webex connection for today's call. Hopefully this will allow us to be as efficient as possible, as both she and I can only allot an hour for the call.
>
> So, full connection details:
>
> Phone: (b) (5) CIP , passcode (b) (5) CIP
>
> Instant Net Conference Details:
>
> ---
>
> Meeting Number: (b) (5)
>
> Meeting Passcode:
>
> Meeting Host: HEATHER M BELL
>
> Join Instructions for Instant Net Conference:
>
> 1. Join the meeting now:
>
> (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
>
> If using Google Chrome, I suggest copying the link and pasting it into Explorer.
>
> 2. Enter the required fields.
>
> 3. Indicate that you have read the Privacy Policy.
>
> 4. Click on Proceed.
>
> --
> *Mary Parkin*

Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
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Street address 145 North Center St, Escalante, UT 84726
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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Google Calendar on behalf of Mary Parkin
To:	mark_mccollough@fws.gov; Bryon Holt; Kate Novak; Kurt Broderdorp; Jeffrey Dillon; Lisa Solberg Schwab; Ben Conard; Tara Nicolaysen; Brady McGee; Megan Kosterman; Heather Bell; Jessica Hogrefe; Tamara Smith; David Smith; Eric Hein; Jennifer Szymanski; Jeff Krupka; Leslie Ellwood; Paul Casey; Jodi Bush; Seth Willey; Mark Sattelberg; Bridget Fahey; Karl Halupka; Jonathan Cummings; Rollie White; Michael Carrier; Dennis Mackey; Gary Miller; Paul Henson; Tom Chapman; Tyler Abbott; Mark Maghini; Ann Belleman; Michelle Eames; Anthony Tur; Laury Zicari; Brent Esmoil; Grant Canterbury; Krishna Gifford; Sarah Hall; Martin Miller
Subject:	Kickoff Call for Canada Lynx Species Status Assessment (SSA): 10-11 am MDT
Start:	Thursday, May 28, 2015 12:00:00 PM
End:	Thursday, May 28, 2015 1:00:00 PM
Location:	[redacted] passcode: [redacted] -- see webinar information in the Description box below
Attachments:	invite.ics

HYPERLINK "https://www.google.com/calendar/event?
action VIEW&eid NXIzdHF0dDNjbXNhczZzZGM2MmI2Mmdzczggb WFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdmFkYmM4NjM2YWU3NjRiZTI3NGJmODYwNDNkMTc5ZTVmZWVkOGI1MzM&ctz America/New_York&hl en"more details »

Kickoff Call for Canada Lynx Species Status Assessment (SSA): 10-11 am MDT

This purpose of this webinar is to discuss the project plan for assessing the status of the Canada lynx DPS in order to complete a 5-year review and, as warranted, a recovery plan for the DPS by January 2018. Most importantly, membership on the core SSA team and management team needs to be confirmed, based on a clear understanding of the expectations for each team member. A call agenda will be provided before Thursday.
When
Thu May 28, 2015 12pm – 1pm Eastern Time
Where
tbd (will provide call and webinar info on 5/26) (HYPERLINK "https://maps.google.com/maps?q tbd (will provide call and webinar info on 5/26)&hl en"map)
Video call
HYPERLINK "https://plus.google.com/hangouts/_/doi.gov/mary-parkin?hceid bWFyeV9wYXJraW5AZndzLmdvdg.5r3tqtt3cmsas6sdc62b62gss8"https://plus.google.com/hangouts/_/doi.gov/mary-parkin
Calendar
mark_mccollough@fws.gov
Who
• Mary Parkin
- organizer
• Bryon Holt
• Kate Novak
• Kurt Broderdorp
• Jeffrey Dillon
• Lisa Solberg Schwab
• Ben Conard
• Tara Nicolaysen
• Brady McGee
• Megan Kosterman
• Heather Bell
• Jessica Hogrefe
• Tamara Smith
• David Smith
• Eric Hein
• Jennifer Szymanski
• Jeff Krupka
• Leslie Ellwood
• Paul Casey
• Jodi Bush
• Seth Willey
• Mark Sattelberg
• Bridget Fahey
• Karl Halupka
• Jonathan Cummings
• Rollie White
• Michael Carrier
• Dennis Mackey
• Gary Miller
• Paul Henson
• Tom Chapman
• Tyler Abbott
• Mark Maghini
• Mark McCollough
• Ann Belleman
• Michelle Eames
• Anthony Tur
• Laury Zicari
• Grant Canterbury
• Krishna Gifford
• Sarah Hall
• Martin Miller

Going?
HYPERLINK "https://www.google.com/calendar/event?
action RESPOND&eid NXIzdHF0dDNjbXNhczZzZGM2MmI2Mmdzczggb WFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&rst 1&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdmFkYmM4NjM2YWU3NjRiZTI3NGJmODYwNDNkMTc5ZTVmZWVkOGI1MzM&ctz America/New_York&hl en"Yes - HYPERLINK "https://www.google.com/calendar/event?
action RESPOND&eid NXIzdHF0dDNjbXNhczZzZGM2MmI2Mmdzczggb WFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&rst 3&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdmFkYmM4NjM2YWU3NjRiZTI3NGJmODYwNDNkMTc5ZTVmZWVkOGI1MzM&ctz America/New_York&hl en"Maybe - HYPERLINK "https://www.google.com/calendar/event?
action RESPOND&eid NXIzdHF0dDNjbXNhczZzZGM2MmI2Mmdzczggb WFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&rst 2&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdmFkYmM4NjM2YWU3NjRiZTI3NGJmODYwNDNkMTc5ZTVmZWVkOGI1MzM&ctz America/New_York&hl en"No HYPERLINK "https://www.google.com/calendar/event?
action VIEW&eid NXIzdHF0dDNjbXNhczZzZGM2MmI2Mmdzczggb WFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdmFkYmM4NjM2YWU3NjRiZTI3NGJmODYwNDNkMTc5ZTVmZWVkOGI1MzM&ctz America/New_York&hl en"more options »

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From: Lisa Mandell
To: Tamara Smith
Cc: Ann Belleman
Subject: RE: Updated Invitation: Kickoff Call for Canada Lynx Species Status Assessment (S... @ Thu May 28, 2015 11am - 12pm (tamara_smith@fws.gov)
Date: Wednesday, May 27, 2015 4:02:50 PM

I think you'll both be on the call, too. I just got off the phone with Jodi Busch, the Field Supervisor from the Helena, MT FO. I also heard about this in passing during a call with Ann earlier today. Soooo, Jodi was asking for your help, and I told her that you could help but I expressed reservations in how much time. She's going to send me an email with some additional info, which I can share with you. We should have a three-way discussion about how much staff involvement is needed, once you get a better sense of how much time is expected for all this SSA work.

--
Lisa Mandell
Deputy Field Supervisor
U.S. Fish and Wildlife Service
Twin Cities Ecological Services Field Office
4101 American Blvd. East
Bloomington, Minnesota 55425
612-725-3548 x2201
Serving Minnesota and Wisconsin

From: Smith, Tamara [mailto:tamara_smith@fws.gov]
Sent: Wednesday, May 27, 2015 11:58 AM
To: Lisa Mandell
Subject: Fwd: Updated Invitation: Kickoff Call for Canada Lynx Species Status Assessment (S... @ Thu May 28, 2015 11am - 12pm (tamara_smith@fws.gov)

fyi - tomorrow's lynx SSA kickoff call. I think Ann and I will both be on the call, but I am not sure. I'm not sure what type of commitment they are looking for from us at this point.

---------- Forwarded message ----------
From: **Mary Parkin** <mary_parkin@fws.gov>
Date: Wed, May 27, 2015 at 11:53 AM
Subject: Updated Invitation: Kickoff Call for Canada Lynx Species Status Assessment (S... @ Thu May 28, 2015 11am - 12pm (tamara_smith@fws.gov)
To: "tamara_smith@fws.gov" <tamara_smith@fws.gov>, Heather Bell <heather_bell@fws.gov>, Tom Chapman <tom_chapman@fws.gov>, Eric Hein <eric_hein@fws.gov>, Kate Novak <kate_novak@fws.gov>, Michael Carrier <michael_carrier@fws.gov>, Jodi Bush <jodi_bush@fws.gov>, Paul Casey <paul_casey@fws.gov>, Grant Canterbury <grant_canterbury@fws.gov>, Paul Henson <paul_henson@fws.gov>, Tara Nicolaysen <tara_nicolaysen@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Gary Miller <gary_miller@fws.gov>, Bridget Fahey <bridget_fahey@fws.gov>, Megan Kosterman <megan_kosterman@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Jennifer Szymanski <jennifer_szymanski@fws.gov>, Michelle Eames <michelle_eames@fws.gov>, Seth Willey <seth_willey@fws.gov>, Lisa Solberg Schwab <lisa_solbergschwab@fws.gov>,

Martin Miller <martin_miller@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Anthony Tur <anthony_tur@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Brent Esmoil <brent_esmoil@fws.gov>, Tyler Abbott <tyler_abbott@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, David Smith <drsmith@usgs.gov>, Jonathan Cummings <jwcummings@usgs.gov>, Brady McGee <brady_mcgee@fws.gov>, Karl Halupka <karl_halupka@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Leslie Ellwood <leslie_ellwood@fws.gov>

This event has been changed.

more details »

Kickoff Call for Canada Lynx Species Status Assessment (SSA): 10-11 am MDT

Changed: This purpose of this webinar is to discuss the project plan for assessing the status of the Canada lynx DPS in order to complete a 5-year review and, as warranted, a recovery plan for the DPS by January 2018. Most importantly, membership on the core SSA team and management team needs to be confirmed, based on a clear understanding of the expectations for each team member.

Webinar information below:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

1. To join the meeting, copy and paste the following URL:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

When	Thu May 28, 2015 11am – 12pm Central Time
Where	**Changed:** 866-857-8504, passcode: 7620543 -- see webinar information in the Description box below (map)
Video call	(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
Calendar	tamara_smith@fws.gov
Who	• Mary Parkin - organizer • Heather Bell • Tom Chapman • Ben Conard • Jessica Hogrefe • Eric Hein • Kate Novak • Michael Carrier • Jodi Bush • Paul Casey • Grant Canterbury • Paul Henson

- Tara Nicolaysen
- Jeff Krupka
- Dennis Mackey
- Laury Zicari
- Gary Miller
- Tamara Smith
- Bridget Fahey
- Megan Kosterman
- Ann Belleman
- Jennifer Szymanski
- Michelle Eames
- Bryon Holt
- Seth Willey
- Lisa Solberg Schwab
- Martin Miller
- Mark Maghini
- Sarah Hall
- Anthony Tur
- Mark McCollough
- Rollie White
- Krishna Gifford
- Brent Esmoil
- Tyler Abbott
- Kurt Broderdorp
- Mark Sattelberg
- David Smith
- Jonathan Cummings
- Brady McGee
- Karl Halupka
- Jeffrey Dillon
- Leslie Ellwood

Going? **Yes** - **Maybe** - **No** more options »

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To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office

4101 American Boulevard East
Bloomington, MN 55425
612-725-3548 ext. 2219
612-600-1599 cell

From: Paul Phifer
To: Zicari, Laury
Cc: Spencer Simon; Martin Miller; Mary Parkin
Subject: Re: Canada Lynx SSA Core Team
Date: Thursday, May 28, 2015 7:25:04 AM

---

ok

Sent from my iPad

On May 28, 2015, at 8:04 AM, Zicari, Laury <laury_zicari@fws.gov> wrote:

> For your information. Mark was name requested by Jodi and the species lead, Jim Zelenak. We will adjust work priorities as needed. I made her aware of the legal challenge to the ITP, etc. and potential workload commitments in the next months.
> ---------- Forwarded message ----------
> From: **Bush, Jodi** <jodi_bush@fws.gov>
> Date: Wed, May 27, 2015 at 6:37 PM
> Subject: Canada Lynx SSA Core Team
> To: Tyler Abbott <tyler_abbott@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Ben Conard <ben_conard@fws.gov>, Laury Zicari <laury_zicari@fws.gov>
> Cc: Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>
>
> Dear Managers and Core Team Members :
>
> As you are aware, Region 6 is initiating a status review of the contiguous U.S. DPS of the Canada lynx as a first step in completing a court-ordered recovery plan for the DPS. The court's deadline for the plan is Jan. 15, 2018. The Montana ES Office is the lead office for this effort.
>
> We will be using the Species Status Assessment (SSA) framework to evaluate the current status of the DPS, determine the major drivers of the DPS's viability, and produce an SSA report, which will provide the scientific underpinnings for the recovery plan and any other future listing decisions we may need to make regarding the DPS (e.g., 5-year review, delisting/uplisting determinations if needed, etc.).
>
> Because the DPS spans parts of four other Service Regions (1, 2, 3, and 5), it is very important that field biologists most familiar with the status of lynx subpopulations in the DPS assist with and contribute meaningfully to the development, review, and completion of the SSA report and recovery plan.
>
> In particular, we will need dedicated assistance from the appropriate biologists in the Idaho and/or Washington FOs (R1) , Twin Cities FO (R3),

Maine FO (R5), and Colorado and/or Wyoming FOs (R6).

As I indicated in our phone conversation, your staff member has been identified as a participant in the "core" team. This email is to confirm with you that you approve your staffs involvement as "core" team members in the development, review, and completion of the SSA report and subsequent Canada Lynx recovery plan.

As we discussed, I estimate that this effort could take anywhere from 10 to 25% of their time.

It will be especially important that the Core Team biologists assist with:

(1) collection and interpretation of information relating to the status of and potential threats to those subpopulations;
(2) in coordination with guidance from the SSA facilitation team, contacting and arranging participation by lynx experts most familiar with the status, ecology, population dynamics, and habitat needs of those subpopulations; and
(3) writing, editing, and reviewing relevant parts of the SSA report, five-year review, and recovery plan, if needed.

In addition, Core Team members are expected to coordinate with internal Service Staff in their region and area of coverage and in that same area - to be the Service Point person for Canada Lynx with our external partners during the process.

Thank you for your commitment of staff. This is an important effort and we are excited to get started.

On May 28 we are having a general conference call discussing where we are and the next steps. That information is below. If you have any questions about the process -please give me a call. Thanks JB

(b) (5) CIP, passcode: (b) (5) CIP
-- see webinar information in the Description box below

This purpose of this webinar is to give an update on where we are with the Canada lynx recovery planning process.

Webinar information below:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

1. To join the meeting, copy and paste the following URL:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP

(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP

2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--

Laury Zicari
Field Supervisor
Maine Field Office
17 Godfrey Drive, Suite 2
Orono, ME 04473
207-866-3344 x 1111
Fax 866-3351
Cell 207-949-0561

From: Lisa Mandell
To: Ann Belleman
Cc: Tamara Smith
Subject: FW: Canada Lynx SSA Core Team
Date: Thursday, May 28, 2015 7:50:51 AM

FYI – Your name was also part of the conversation with Montana ES. This email does not have the time for the webinar, but I think you are already aware of that.

--
Lisa Mandell
Deputy Field Supervisor
U.S. Fish and Wildlife Service
Twin Cities Ecological Services Field Office
4101 American Blvd. East
Bloomington, Minnesota 55425
612-725-3548 x2201
Serving Minnesota and Wisconsin

From: Bush, Jodi [mailto:jodi_bush@fws.gov]
Sent: Wednesday, May 27, 2015 5:37 PM
To: Tyler Abbott; Lisa Mandell; Ben Conard; Laury Zicari
Cc: Kurt Broderdorp; Tamara Smith; Bryon Holt; Mark McCollough
Subject: Canada Lynx SSA Core Team

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(b) (5) CIP, passcode: (b) (5) CIP
-- see webinar information in the Description box below

This purpose of this webinar is to give an update on where we are with the Canada lynx recovery planning process.

Webinar information below:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

1. To join the meeting, copy and paste the following URL:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

Jodi L. Bush
Field Supervisor

Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From:	Bell, Heather
To:	Mary Parkin
Cc:	Jim Zelenak
Subject:	Re: Updated Invitation: Weekly lynx SSA coordination call: 11-12 MT @ Weekly from 11am to 12pm on Monday from Mon Jun 1 to Mon Nov 30 (heather_bell@fws.gov)
Date:	Tuesday, June 02, 2015 8:37:08 AM

Shoot, if i missed a call I am sorry! I had another overlapping call, for just this week.

Heather Bell
Ecological Services HQ
Branch of Conservation Integration
SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff
at https://sites.google.com/a/fws.gov/ssa/ and the REV Google Site: https://sites.google.com/a/fws.gov/rev/

On Mon, Jun 1, 2015 at 9:14 AM, Mary Parkin <mary_parkin@fws.gov> wrote:

> **This event has been changed.**
>
> **Weekly lynx SSA coordination call: 11-12 MT** more details »
>
> When Weekly from 11am to 12pm on Monday from Mon Jun 1 to Mon Nov 30 Mountain Time
>
> Where **Changed:** (b) (5) CIP , passcode: (b) (5) (map)
>
> Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin
>
> Calendar heather_bell@fws.gov
>
> Who
> - Mary Parkin - organizer
> - Heather Bell
> - Jim Zelenak
>
> Going? All events in this series: **Yes** - **Maybe** - **No** more options »
>
> Invitation from Google Calendar
>
> You are receiving this email at the account heather_bell@fws.gov because you are subscribed for updated invitations on calendar heather_bell@fws.gov.
>
> To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

From:	Zelenak, Jim
To:	Bell, Heather
Cc:	Mary Parkin
Subject:	Re: Updated Invitation: Weekly lynx SSA coordination call: 11-12 MT @ Weekly from 11am to 12pm on Monday from Mon Jun 1 to Mon Nov 30 (heather_bell@fws.gov)
Date:	Tuesday, June 02, 2015 8:49:28 AM

No worries - Mary and I wrapped up the SSA, 5-year recommendation, and the recovery plan. Final copies of each to follow....

;-)

On Tue, Jun 2, 2015 at 8:37 AM, Bell, Heather <heather_bell@fws.gov> wrote:

> Shoot, if i missed a call I am sorry! I had another overlapping call, for just this week.
>
> Heather Bell
> Ecological Services HQ
> Branch of Conservation Integration
> SSA Framework Team Lead
> Remotely Located at
> 134 S. Union Blvd
> Lakewood, CO 80228
> 303-236-4514
>
> Check it out! SSA Framework - Google Site for Staff
> at https://sites.google.com/a/fws.gov/ssa/ and the REV Google
> Site: https://sites.google.com/a/fws.gov/rev/
>
> On Mon, Jun 1, 2015 at 9:14 AM, Mary Parkin <mary_parkin@fws.gov> wrote:
>
> **This event has been changed.**
>
> **Weekly lynx SSA coordination call: 11-12 MT** **more details »**
>
> When: Weekly from 11am to 12pm on Monday from Mon Jun 1 to Mon Nov 30 Mountain Time
>
> Where: **Changed:** (b) (5) CIP , passcode: (b) (5) (map)
>
> Video call: https://plus.google.com/hangouts/_/doi.gov/mary-parkin
>
> Calendar: heather_bell@fws.gov
>
> Who:
> - Mary Parkin - organizer
> - Heather Bell
> - Jim Zelenak
>
> Going? All events in this series: **Yes** - **Maybe** - **No** more options »
>
> Invitation from Google Calendar
>
> You are receiving this email at the account heather_bell@fws.gov because you are subscr bed for updated invitations on calendar heather_bell@fws.gov.

> To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Smith, Tamara
To: Zelenak, Jim
Subject: Re: Lynx SSA Core Team Biweekly Calls, etc.
Date: Monday, June 08, 2015 5:22:54 PM

I can make the call on Thursday. Talk to you then!

On Mon, Jun 8, 2015 at 4:48 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> I've heard back from all of you, and it looks like Tuesday mornings will work best for our calls. So we will plan on the 2nd and 4th Tuesdays of each month from 10-11 Mountain Time.
>
> However, because of prior commitments, we will not have the first call tomorrow (Tues., June 9) but instead will call this Thursday, June 11, 10-11 Mountain Time. Please let me know if you can make the call then. Between now and then i will send out a few agenda bullets of topics we hope to cover.
>
> Call-in No. (b) (5) CIP
> Passcode: (b) (5)
>
> Our 2nd call will be June 23. I will work on getting these out as Google invitations so they will show up on your calendars. Mark is on leave this week and so will miss the first call, and Bryon has leave scheduled for the 2nd call - but we will get them caught up when they return!
>
> We are also working on a Google Drive site that I will forward once we populate it a little. This will be a place to store, review, and edit important documents.
>
> I've copied Mary Parkin and Heather Bell - they will be joining these calls as often as they are able, and they are our two leads for assistance in implementing the SSA framework, conducting expert elicitation meetings, and coordinating with State and other partners, among other assistance I'm sure they will offer. We also may be joined from time to time by one or more USGS folks who specialize in SSA implementation, viability modeling, and structured decision making.
>
> Look forward to talking with you on Thursday.
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425

612-725-3548 ext. 2219
612-600-1599 cell

From: Parkin, Mary
To: Zelenak, Jim
Subject: Re: Lynx SSA Core Team Biweekly Calls, etc.
Date: Monday, June 08, 2015 8:48:16 PM

This is great, Jim. I look forward to staying involved with the lynx SSA as a process person, but I must say, the whole effort couldn't be in better hands than yours.

Talk on Thursday,
Mary

On Mon, Jun 8, 2015 at 5:48 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> I've heard back from all of you, and it looks like Tuesday mornings will work best for our calls. So we will plan on the 2nd and 4th Tuesdays of each month from 10-11 Mountain Time.
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> Look forward to talking with you on Thursday.
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> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Mary Parkin

Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Holt, Bryon
To: Zelenak, Jim
Subject: Re: Lynx SSA Core Team Biweekly Calls, etc.
Date: Tuesday, June 09, 2015 7:25:03 AM

Thanks Jim. I can make the call this Thursday.

Bryon

On Mon, Jun 8, 2015 at 2:48 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> I've heard back from all of you, and it looks like Tuesday mornings will work best for our calls. So we will plan on the 2nd and 4th Tuesdays of each month from 10-11 Mountain Time.
>
> However, because of prior commitments, we will not have the first call tomorrow (Tues., June 9) but instead will call this Thursday, June 11, 10-11 Mountain Time. Please let me know if you can make the call then. Between now and then i will send out a few agenda bullets of topics we hope to cover.
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> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
****
Bryon Holt

U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

From: Zelenak, Jim
To: Mark McCollough
Subject: Re: Lynx SSA Core Team Biweekly Calls, etc.
Date: Wednesday, June 10, 2015 4:06:52 PM

Understood. We'll miss having you on the call, Mark, but we'll catch up later, before the next call. Enjoy your leave and don't think about lynx.

Send fishing pictures soon!

On Wed, Jun 10, 2015 at 2:04 PM, Mark McCollough <mark_mccollough@fws.gov> wrote:

> Jim. I am on annual leave and unable to participate in Lynx call tomorrow. Mark
>
> Sent from my iPhone
>
> On Jun 8, 2015, at 5:48 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> Hi Team,
>
> I've heard back from all of you, and it looks like Tuesday mornings will work best for our calls. So we will plan on the 2nd and 4th Tuesdays of each month from 10-11 Mountain Time.
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> Jim
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> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601

> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Heather Bell
Cc: Michael Thabault
Subject: Re: Invitation: Call to discuss Lynx and AFWA letter @ Tue Jun 16, 2015 1pm - 1:30pm (jodi_bush@fws.gov)
Date: Tuesday, June 16, 2015 4:58:51 AM

Well believe it or not -there is no phone service except pay phone at the hotel (of which there is only one). I tried my calling card last nite and it doesn't work and of course we have no internet in the Park (Did I say I am at Glacier NP?) in the rooms. Only in the lobby. and its terribly slow.

In any case I'm done here early weds morning and heading back. Can we try a call early afternoon then? I'll check my email as I can -to get the time. Thanks. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Jun 15, 2015 at 3:30 PM, Heather Bell <heather_bell@fws.gov> wrote:

Call to discuss Lynx and AFWA letter more details »

Phone (b) (5) CIP
Passcode (b) (5)

When	Tue Jun 16, 2015 1pm – 1:30pm Mountain Time
Where	Phone 877-501-8335 Passcode 9984367 (map)
Video call	https://plus.google.com/hangouts/_/doi.gov/heather-bell
Calendar	jodi_bush@fws.gov
Who	• Heather Bell - organizer • Jodi Bush • Michael Thabault

Going? Yes - Maybe - No more options »

Invitation from Google Calendar

You are receiving this email at the account jodi_bush@fws.gov because you are subscribed for invitations on calendar jodi_bush@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

From:	Google Calendar
To:	kurt_broderdorp@fws.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; bryon_holt@fws.gov; jim_zelenak@fws.gov; heather_bell@fws.gov; mary_parkin@fws.gov
Cc:	kurt_broderdorp@fws.gov; heather_bell@fws.gov; bryon_holt@fws.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov; jim_zelenak@fws.gov
Subject:	[Update] Biweekly Call: Lynx SSA Core Team, 10-11 AM MDT
Date:	Wednesday, June 17, 2015 12:02:19 PM

Hi folks,
Just a reminder to check your calendars for next week's lynx call.
Thanks!

Biweekly Call: Lynx SSA Core Team, 10-11 AM MDT

Hosted by Jim Zelenak.

When	Tue Jun 23, 2015 12pm – 1pm Eastern Time
Where	Call-in: 8(b) (5) CIP Passcode: (b) (5) (map)
Video call	https://plus.google.com/hangouts/_/doi.gov/mary-parkin
Who	• Mary Parkin - organizer • Kurt Broderdorp • Heather Bell • Bryon Holt • Mark McCollough • Tamara Smith • Jim Zelenak

From: Zelenak, Jim
To: Mary Parkin; Heather Bell; Seth Willey; Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Fwd: Invitation for Instant Net Conference
Date: Monday, June 22, 2015 5:30:19 PM
Attachments: 2015 06 22 Draft Lynx SSA Expert matrix.docx

Hi Team:

Below is info for joining a webinar tomorrow - mostly so we can do some real-time additions to the SSA Cardinal Questions table (which Core Team folks have been working on, yes?), and to the attached draft expert elicitation matrix (feel free to fill in names of experts in your geography). the column headings are pretty general right now - focusing on the limiting parts of the CH PCE (boreal forest, hares, and snow), as well as habitat and climate modeling, and connectivity with Canada. We made need to refine/adjust. We also need to talk some about the project plan and just how we think we might be able to meet the project schedule.

Call-in info is the same:

(b) (5) CIP
Passcode: (b) (5)

Talk to you all tomorrow!

Thanks,

Jim

---------- Forwarded message ----------
From: <e-meetings@mymeetings.com>
Date: Mon, Jun 22, 2015 at 3:18 PM
Subject: Invitation for Instant Net Conference
To: JIM_ZELENAK@fws.gov

You are invited to join a meeting hosted by BRENT ESMOIL. Meeting details are listed below.

Meeting Date: 06/23/2015
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Parkin, Mary
To: Zelenak, Jim
Subject: Re: Invitation for Instant Net Conference
Date: Tuesday, June 23, 2015 9:44:51 AM

---

p.s. I plan on taking notes today, which I'll then distribute to you all. One thing, if you want to turn the webex over to me for the expert matrix, I'll need a refresher on what to do technically. for today, it might be most efficient if, on the expert matrix, you and I tag-team the discussion while you type in any additional names on screen.

Between now and the next call, I'll work with you and Heather on how to share screens. Just been too long since I've done it.

Mary

On Tue, Jun 23, 2015 at 11:39 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Thanks for getting this info out, Jim! I was just getting ready to belatedly add it to the Calendar for today. I'll go ahead and add the webex info to the recurring Calendar entries.
>
> Talk to you soon,
> Mary
>
> On Mon, Jun 22, 2015 at 5:30 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Team:
> >
> > Below is info for joining a webinar tomorrow - mostly so we can do some real-time additions to the SSA Cardinal Questions table (which Core Team folks have been working on, yes?), and to the attached draft expert elicitation matrix (feel free to fill in names of experts in your geography). the column headings are pretty general right now - focusing on the limiting parts of the CH PCE (boreal forest, hares, and snow), as well as habitat and climate modeling, and connectivity with Canada. We made need to refine/adjust. We also need to talk some about the project plan and just how we think we might be able to meet the project schedule.
> >
> > Call-in info is the same:
> >
> > (b) (5) CIP
> > Passcode: (b) (5)
> >
> > Talk to you all tomorrow!
> >
> > Thanks,
> >
> > Jim
> >
> > ---------- Forwarded message ----------
> > From: <e-meetings@mymeetings.com>
> > Date: Mon, Jun 22, 2015 at 3:18 PM
> > Subject: Invitation for Instant Net Conference
> > To: JIM_ZELENAK@fws.gov

You are invited to join a meeting hosted by BRENT ESMOIL. Meeting details are listed below.

Meeting Date: 06/23/2015
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
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Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726

Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Google Calendar

To: michael_carrier@fws.gov; megan_kosterman@fws.gov; lisa_solbergschwab@fws.gov; krishna_gifford@fws.gov; tara_nicolaysen@fws.gov; seth_willey@fws.gov; michelle_eames@fws.gov; tom_chapman@fws.gov; martin_miller@fws.gov; jennifer_szymanski@fws.gov; ann_belleman@fws.gov; rollie_white@fws.gov; jodi_bush@fws.gov; tyler_abbott@fws.gov; anthony_tur@fws.gov; karl_halupka@fws.gov; leslie_ellwood@fws.gov; bridget_fahey@fws.gov; bryon_holt@fws.gov; heather_bell@fws.gov; drsmith@usgs.gov; kate_novak@fws.gov; jwcummings@usgs.gov; laury_zicari@fws.gov; ben_conard@fws.gov; dennis_mackey@fws.gov; mark_sattelberg@fws.gov; brady_mcgee@fws.gov; paul_casey@fws.gov; sarah_hall@fws.gov; mary_parkin@fws.gov; eric_hein@fws.gov; kurt_broderdorp@fws.gov; jessica_hogrefe@fws.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; jeffrey_dillon@fws.gov; jeff_krupka@fws.gov; grant_canterbury@fws.gov; mark_maghini@fws.gov; gary_miller@fws.gov; paul_henson@fws.gov; jim_zelenak@fws.gov

Cc: jessica_hogrefe@fws.gov; jeffrey_dillon@fws.gov; tara_nicolaysen@fws.gov; tyler_abbott@fws.gov; paul_henson@fws.gov; kate_novak@fws.gov; seth_willey@fws.gov; megan_kosterman@fws.gov; drsmith@usgs.gov; bryon_holt@fws.gov; anthony_tur@fws.gov; ben_conard@fws.gov; tom_chapman@fws.gov; michael_carrier@fws.gov; rollie_white@fws.gov; mark_maghini@fws.gov; sarah_hall@fws.gov; jodi_bush@fws.gov; laury_zicari@fws.gov; mary_parkin@fws.gov; ann_belleman@fws.gov; grant_canterbury@fws.gov; leslie_ellwood@fws.gov; martin_miller@fws.gov; gary_miller@fws.gov; jennifer_szymanski@fws.gov; bridget_fahey@fws.gov; paul_casey@fws.gov; mark_sattelberg@fws.gov; michelle_eames@fws.gov; dennis_mackey@fws.gov; eric_hein@fws.gov; kurt_broderdorp@fws.gov; heather_bell@fws.gov; krishna_gifford@fws.gov; lisa_solbergschwab@fws.gov; brady_mcgee@fws.gov; jwcummings@usgs.gov; karl_halupka@fws.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov; jeff_krupka@fws.gov

Subject: [Update] Lynx SSA Coordination Call

Date: Thursday, June 25, 2015 3:28:26 PM

Monthly Lynx SSA Coordination Call - July 7, 10-11 AM Mountain Time

(b) (5) CIP
(b) (5)
CIP

Webinar info to follow if needed.

Lynx SSA Coordination Call

When Tue Jul 7, 2015 10am – 11am Mountain Time

Video call https://plus.google.com/hangouts/_/doi.gov/jim-zelenak

Who
- Jim Zelenak - organizer

From: Bush, Jodi
To: Jim Zelenak
Subject: Re: [Update] Lynx SSA Coordination Call
Date: Thursday, June 25, 2015 3:52:49 PM

Jim -you'll need to go in and make this a repeating request. let me know if you need help. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Thu, Jun 25, 2015 at 3:28 PM, <jim_zelenak@fws.gov> wrote:

> Monthly Lynx SSA Coordination Call - July 7, 10-11 AM Mountain Time
>
> (b) (5) CIP
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> CIP
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> Video call https://plus.google.com/hangouts/_/doi.gov/jim-zelenak
>
> Who
> - Jim Zelenak - organizer

From:	Hall, Sarah
To:	Tom McDowell; Jeffrey Chan; Dennis Mackey; Kim Garner
Subject:	Fwd: FW: SIGNATURE NEEDED: Final Lynx Project Plan
Date:	Friday, June 26, 2015 10:44:39 AM
Attachments:	2015 06 25 Proj Plan Canada Lynx SSA FINAL.pdf Signature Page Only_2015 06 25 Proj Plan Canada Lynx SSA FINAL.docx 2015 06 25 Proj Plan Canada Lynx SSA FINAL.docx

---

Hi folks,

Wanted to be sure you saw this request for PL/ARD signatures on the lynx SSA/RP/5-year project plan. Let me know if you have any questions or concerns.

Also, please let me know when your PL signs; Terry will want to know that they are okay with the plan before she signs.

Thank you,
Sarah

Sarah Hall
Endangered Species Recovery Program Manager
USFWS Pacific Region

---------- Forwarded message ----------
From: **Theresa Rabot** <theresa_rabot@fws.gov>
Date: Fri, Jun 26, 2015 at 8:07 AM
Subject: FW: SIGNATURE NEEDED: Final Lynx Project Plan
To: Marilet Zablan <marilet_zablan@fws.gov>, Sarah Hall <sarah_hall@fws.gov>
Cc: sCynthia Barry <Cynthia_Barry@fws.gov>, Deborah Riley <Deborah_Riley@fws.gov>

Please coordinate with the field offices, thanks

From: Bush, Jodi [mailto:jodi_bush@fws.gov]
Sent: Friday, June 26, 2015 8:00 AM
To: Eric Rickerson; Michael Carrier; Mark Sattelberg; Ann Timberman; Drue DeBerry; Laury Zicari; Tom Chapman; Michael Thabault; Theresa Rabot; Paul Phifer; Lisa Mandell; Michelle Shaughnessy; Lynn Lewis; Wally Murphy
Cc: Jeff Krupka; Bryon Holt; Kurt Broderdorp; Tamara Smith; Ann Belleman; Mark McCollough; Jim Zelenak; Anthony Tur; Seth Willey; Kit Hershey; Sarah Quamme; Laura Ragan; Krishna Gifford; Eric Hein
Subject: SIGNATURE NEEDED: Final Lynx Project Plan

Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.

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Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush

Field Supervisor

Montana Ecological Services Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225, ext.205

From:	Bush, Jodi
To:	Eric Rickerson; Michael Carrier; Mark Sattelberg; Ann Timberman; Drue DeBerry; Laury Zicari; Tom Chapman; Michael Thabault; Theresa Rabot; Paul Phifer; Lisa Mandell; Michelle Shaughnessy; Lynn Lewis; Wally Murphy
Cc:	Jeff Krupka; Bryon Holt; Kurt Broderdorp; Tamara Smith; Ann Belleman; Mark McCollough; Jim Zelenak; Anthony Tur; Seth Willey; Kit Hershey; Sarah Quamme; Laura Ragan; Krishna Gifford; Eric Hein
Subject:	SIGNATURE NEEDED: Final Lynx Project Plan
Date:	Friday, June 26, 2015 11:00:03 AM
Attachments:	2015 06 25 Proj Plan Canada Lynx SSA FINAL.pdf Signature Page Only 2015 06 25 Proj Plan Canada Lynx SSA FINAL.docx 2015 06 25 Proj Plan Canada Lynx SSA FINAL.docx

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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From: Garner, Kim
To: Hall, Sarah
Cc: Tom McDowell; Jeffrey Chan; Dennis Mackey; Michael Carrier
Subject: Re: FW: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Friday, June 26, 2015 11:20:48 AM

Sarah, Mike has signed this and sent his signature to Jim today; please let Terry know we support the plan. Thanks,

Kim

****

Kim Garner
Chief, Classification and Recovery Branch
Idaho Fish and Wildlife Office
U.S. Fish and Wildlife Service
1387 S. Vinnell Way, Room 368
Boise, ID 83709
work: (208) 378-5265

On Fri, Jun 26, 2015 at 10:44 AM, Hall, Sarah <sarah_hall@fws.gov> wrote:

> Hi folks,
>
> Wanted to be sure you saw this request for PL/ARD signatures on the lynx SSA/RP/5-year project plan. Let me know if you have any questions or concerns.
>
> Also, please let me know when your PL signs; Terry will want to know that they are okay with the plan before she signs.
>
> Thank you,
> Sarah
>
> **Sarah Hall**
> **Endangered Species Recovery Program Manager**
> **USFWS Pacific Region**
>
> ---------- Forwarded message ----------
> From: **Theresa Rabot** <theresa_rabot@fws.gov>
> Date: Fri, Jun 26, 2015 at 8:07 AM
> Subject: FW: SIGNATURE NEEDED: Final Lynx Project Plan
> To: Marilet Zablan <marilet_zablan@fws.gov>, Sarah Hall <sarah_hall@fws.gov>
> Cc: sCynthia Barry <Cynthia_Barry@fws.gov>, Deborah Riley <Deborah_Riley@fws.gov>
>
> Please coordinate with the field offices, thanks
>
> **From:** Bush, Jodi [mailto:jodi_bush@fws.gov]
> **Sent:** Friday, June 26, 2015 8:00 AM

To: Eric Rickerson; Michael Carrier; Mark Sattelberg; Ann Timberman; Drue DeBerry; Laury Zicari; Tom Chapman; Michael Thabault; Theresa Rabot; Paul Phifer; Lisa Mandell; Michelle Shaughnessy; Lynn Lewis; Wally Murphy
Cc: Jeff Krupka; Bryon Holt; Kurt Broderdorp; Tamara Smith; Ann Belleman; Mark McCollough; Jim Zelenak; Anthony Tur; Seth Willey; Kit Hershey; Sarah Quamme; Laura Ragan; Krishna Gifford; Eric Hein
Subject: SIGNATURE NEEDED: Final Lynx Project Plan

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with our state partners to keep them appraised of our progress. It would be helpful if versions of this state letter were sent out from your offices. Please use the version I provide to you as a template.

Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush

Field Supervisor

Montana Ecological Services Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225, ext.205

From: Bush, Jodi
To: Hall, Sarah
Cc: Jim Zelenak; Kit Hershey
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Friday, June 26, 2015 11:23:30 AM

Yes. Apologies. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Fri, Jun 26, 2015 at 10:18 AM, Hall, Sarah <sarah_hall@fws.gov> wrote:

> Hi Jodi,
>
> Could you add me to your mailing list for this issue? (and you can take Kit's name off)
>
> Thank you,
> Sarah
>
> **Sarah Hall**
> **Endangered Species Recovery Program Manager**
> **USFWS Pacific Region**
>
> ---------- Forwarded message ----------
> From: **Kit Hershey** <kit_hershey@fws.gov>
> Date: Fri, Jun 26, 2015 at 8:01 AM
> Subject: Fwd: SIGNATURE NEEDED: Final Lynx Project Plan
> To: Sarah Hall <sarah_hall@fws.gov>
>
> Sent from my iPhone
>
> Begin forwarded message:
>
> **From:** "Bush, Jodi" <jodi_bush@fws.gov>
> **To:** Eric Rickerson <eric_rickerson@fws.gov>, Michael Carrier <michael_carrier@fws.gov>, Mark Sattelberg <mark_sattelberg@fws.gov>, Ann Timberman <ann_timberman@fws.gov>, Drue DeBerry <drue_deberry@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Michael Thabault <michael_thabault@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Michelle Shaughnessy <michelle_shaughnessy@fws.gov>, Lynn Lewis <lynn_lewis@fws.gov>, Wally Murphy <wally_murphy@fws.gov>

Cc: Jeff Krupka <Jeff_Krupka@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Seth Willey <seth_willey@fws.gov>, Kit Hershey <Kit_Hershey@fws.gov>, Sarah Quamme <Sarah_Quamme@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Krishna Gifford <krishna_gifford@fws.gov>, Eric Hein <Eric_Hein@fws.gov>
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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From: Smith, Tamara
To: Lewis, Lynn; Peter Fasbender
Cc: Lisa Mandell; Laura Ragan
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Friday, June 26, 2015 11:51:36 AM

Hi Lynn,

Lisa is out for the day, so I forwarded this on to Pete. I reviewed their draft in May and I don't think it has changed much since then - looks good to me.

Have a nice weekend!

Thanks,
Tam

On Fri, Jun 26, 2015 at 11:43 AM, Lewis, Lynn <lynn_lewis@fws.gov> wrote:

> Are you guys good with me signing this?
>
> Lynn M. Lewis
> Assistant Regional Director -
> Ecological Services
> U.S. Fish and Wildlife Service, Midwest Region
> 5600 American Blvd. West, Suite 990
> Bloomington, MN 55437
> 612 713-5345
> 612 713-5292 Fax
> lynn_lewis@fws.gov
>
> ---------- Forwarded message ----------
> From: **Bush, Jodi** <jodi_bush@fws.gov>
> Date: Fri, Jun 26, 2015 at 9:59 AM
> Subject: SIGNATURE NEEDED: Final Lynx Project Plan
> To: Eric Rickerson <eric_rickerson@fws.gov>, Michael Carrier <michael_carrier@fws.gov>, Mark Sattelberg <mark_sattelberg@fws.gov>, Ann Timberman <ann_timberman@fws.gov>, Drue DeBerry <drue_deberry@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Michael Thabault <michael_thabault@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Michelle Shaughnessy <michelle_shaughnessy@fws.gov>, Lynn Lewis <lynn_lewis@fws.gov>, Wally Murphy <wally_murphy@fws.gov>
> Cc: Jeff Krupka <Jeff_Krupka@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Seth Willey <seth_willey@fws.gov>, Kit Hershey <Kit_Hershey@fws.gov>, Sarah Quamme <Sarah_Quamme@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Krishna Gifford <krishna_gifford@fws.gov>, Eric Hein <Eric_Hein@fws.gov>
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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East

Bloomington, MN 55425
612-725-3548 ext. 2219
612-600-1599 cell

From: Parkin, Mary
To: Zelenak, Jim
Cc: Heather Bell
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, June 29, 2015 8:37:55 AM

Hi Jim,

I think we could take Jodi's response and develop a general statement to give to all those who will be interacting with state partners. Let's talk about this on the call today.

I do believe that we need to have a clear, strong message about the appropriate role of the states (and other partners) in this science-driven process, as miscommunication is a possibility. This would then be something we could disseminate before next week's monthly call and address any questions folks might have.

Cheers,
Mary

On Fri, Jun 26, 2015 at 1:43 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Both!
>
> Jodi told me she was OK with me forwarding to you her response to Paul Phifer's (R5) question (below) about states participating more formally on the SSA, and that she thinks we may hear similar questions from other regions and FOs, given national direction to partner closely with states.
>
> I think her response is fine, but wondered if you two feel we ought to develop a message on this, or just reply case-by-case as needed. If the latter, please let me know if you would recommend any changes in Jodi's response. She said she's happy to talk more with Paul and with others if necessary.
>
> Let me know your thoughts.
>
> Thanks,
>
> Jim
>
> ---------- Forwarded message ----------
> From: **Bush, Jodi** <jodi_bush@fws.gov>
> Date: Fri, Jun 26, 2015 at 11:28 AM
> Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
> To: "Phifer, Paul" <paul_phifer@fws.gov>
>
> We are not. The SSA Service leads have been pretty clear -at least to us - that the Service is developing the SSA and are the core team (with some assistance from USGS). Having said that we will be reaching out to key individuals -with the state, academia and other entities to help us with the science. Their roles will be fluid and will depend upon the questions we are attempting to ask. We are also planning on monthly calls to keep them up to date as the process goes forward. Given the sheer number of states involved, this seemed the best course of action. Am happy to talk about this further if you would like. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Fri, Jun 26, 2015 at 9:34 AM, Phifer, Paul <paul_phifer@fws.gov> wrote:

> Hi Jodi. By my read, we aren't asking states to be on the SSA development team. Is that correct? I see a benefit in having them help draft the SSA. Thoughts? Thanks, Paul
>
> _____
> Paul Phifer, PhD
> Assistant Regional Director - Ecological Services
> Northeast Region
> Dept of the Interior
> US Fish and Wildlife Service
> 413.253.8698 work
> 413.687.4764 cell
>
> On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
>
> > Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.
> >
> > For ease of collating signatures please use any of the following methods to add your signature to the document.
> >
> > 1. Open the attached pdf document in Adobe Reader. Click on the fill and sign tab and make a selection for your signature of the document. **Save and send back to Jim Zelenak.**
> >
> > 2. Sign a hardopy of the signature page (10), **scan and send back to Jim Zelenak.**
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> > 3. Add your signature in the word document by adding /s/ Your Name. **Save and send back to Jim Zelenak.**
> >
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process. To that end, the letter updates where we are now and identifies a monthly coordination call with our state partners to keep them appraised of our progress. It would be helpful if versions of this state letter were sent out from your offices. Please use the version I provide to you as a template.

Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Bush, Jodi
To: Murphy, Wally
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, June 29, 2015 11:53:02 AM

Thanks Wally. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Jun 29, 2015 at 11:24 AM, Murphy, Wally <wally_murphy@fws.gov> wrote:

> Here ya go Jodi. wm
>
> On Fri, Jun 26, 2015 at 8:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
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--
Wally Murphy
NMESFO Supervisor
505/761-4781
CP 505/480-4821
"We are what we repeatedly do. **Excellence** then, is not an act, but a habit." Aristotle

From: Lewis, Lynn
To: Jim Zelenak
Cc: Jodi Bush; Peter Fasbender
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, June 29, 2015 2:24:46 PM
Attachments: lynxtcforo.pdf

Jim:

Here is the R3/TCFO scanned signature page for the lynx final project plan.

Lynn M. Lewis
Assistant Regional Director -
Ecological Services
U.S. Fish and Wildlife Service, Midwest Region
5600 American Blvd. West, Suite 990
Bloomington, MN 55437
612 713-5345
612 713-5292 Fax
lynn_lewis@fws.gov

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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
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(406) 449-5225, ext.205

From: Bush, Jodi
To: Lewis, Lynn
Cc: Jim Zelenak; Peter Fasbender
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, June 29, 2015 2:28:44 PM

Thank you ! JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Jun 29, 2015 at 2:24 PM, Lewis, Lynn <lynn_lewis@fws.gov> wrote:

> Jim:
>
> Here is the R3/TCFO scanned signature page for the lynx final project plan.
>
> Lynn M. Lewis
> Assistant Regional Director -
> Ecological Services
> U.S. Fish and Wildlife Service, Midwest Region
> 5600 American Blvd. West, Suite 990
> Bloomington, MN 55437
> 612 713-5345
> 612 713-5292 Fax
> lynn_lewis@fws.gov
>
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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From: Mackey, Dennis
To: Tom McDowell
Subject: Fwd: Canada Lynx SSA Core Team
Date: Wednesday, July 01, 2015 9:47:46 AM

---

fyi
---------- Forwarded message ----------
From: **Conard, Ben** <ben_conard@fws.gov>
Date: Wed, Jul 1, 2015 at 9:45 AM
Subject: Fwd: Canada Lynx SSA Core Team
To: Dennis Mackey <Dennis_Mackey@fws.gov>, Kim Garner <kim_garner@fws.gov>, Bryon Holt <bryon_holt@fws.gov>

reminder of earlier message sent, and email trail outlining the Lynx SSA task at hand.....

---------- Forwarded message ----------
From: **Conard, Ben** <ben_conard@fws.gov>
Date: Fri, May 29, 2015 at 8:17 AM
Subject: Fwd: Canada Lynx SSA Core Team
To: Michael Carrier <michael_carrier@fws.gov>, Dennis Mackey <Dennis_Mackey@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Russ Holder <russ_holder@fws.gov>
Cc: Laura Williams <laura_williams@fws.gov>, Mark Robertson <mark_robertson@fws.gov>, Kim Garner <kim_garner@fws.gov>

As previously discussed, Idaho FWO identified Bryon Holt as our lead on this lynx SSA project. As a member of the lynx core team, he will need to coordinate with his counterparts in Washington, Boise, Oregon, others?, within R1. The lynx effort is expected to require 10-25% time, which I am sure will ebb and flow.

As you also know, we have refocused Bryon's time and talents onto caribou, lynx, and grizzly bear recovery planning and implementation issues. Bryon is working internally to finalize the caribou classification rule. And his participation is key on the team of partners revising a foundation for future caribou recovery plan. He's also currently assigned one significant consultation: Bog Creek Road, which we anticipate will be LAA grizzly bears.

In order for Bryon to effectively execute these select, priority projects (lynx SSA, caribou classification, caribou recovery planning, and Bog Creek grizzly bear consultation), it will be critical for the office to minimize additional collateral assignments until work products clear. It is equally important for Bryon to carefully out-plan his schedule to avoid conflicts and avoidable delays. With careful planning and disciplined focus, Bryon should be able to handle these items for the foreseeable future.

I am making this point because I as a supervisor, and we as organization, had previously hoisted numerous, conflicting number 1 priorities upon Bryon; resulting in inadequate progress and frustration for our internal and external partners on important projects.

Thanks for your consideration. - Ben

---------- Forwarded message ----------
From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Wed, May 27, 2015 at 3:37 PM
Subject: Canada Lynx SSA Core Team
To: Tyler Abbott <tyler_abbott@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Ben Conard <ben_conard@fws.gov>, Laury Zicari <laury_zicari@fws.gov>
Cc: Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>

Dear Managers and Core Team Members :

As you are aware, Region 6 is initiating a status review of the contiguous U.S. DPS of the Canada lynx as a first step in completing a court-ordered recovery plan for the DPS. The court's deadline for the plan is Jan. 15, 2018. The Montana ES Office is the lead office for this effort.

We will be using the Species Status Assessment (SSA) framework to evaluate the current status of the DPS, determine the major drivers of the DPS's viability, and produce an SSA report, which will provide the scientific underpinnings for the recovery plan and any other future listing decisions we may need to make regarding the DPS (e.g., 5-year review, delisting/uplisting determinations if needed, etc.).

Because the DPS spans parts of four other Service Regions (1, 2, 3, and 5), it is very important that field biologists most familiar with the status of lynx subpopulations in the DPS assist with and contribute meaningfully to the development, review, and completion of the SSA report and recovery plan.

In particular, we will need dedicated assistance from the appropriate biologists in the Idaho and/or Washington FOs (R1) , Twin Cities FO (R3), Maine FO (R5), and Colorado and/or Wyoming FOs (R6).

As I indicated in our phone conversation, your staff member has been identified as a participant in the "core" team. This email is to confirm with you that you approve your staffs involvement as "core" team members in the development, review, and completion of the SSA report and subsequent Canada Lynx recovery plan.

As we discussed, I estimate that this effort could take anywhere from 10 to 25% of their time.

It will be especially important that the Core Team biologists assist with:

(1) collection and interpretation of information relating to the status of and potential threats to those subpopulations;
(2) in coordination with guidance from the SSA facilitation team, contacting and arranging participation by lynx experts most familiar with the status, ecology, population dynamics, and habitat needs of those subpopulations; and

(3) writing, editing, and reviewing relevant parts of the SSA report, five-year review, and recovery plan, if needed.

In addition, Core Team members are expected to coordinate with internal Service Staff in their region and area of coverage and in that same area - to be the Service Point person for Canada Lynx with our external partners during the process.

Thank you for your commitment of staff. This is an important effort and we are excited to get started.

On May 28 we are having a general conference call discussing where we are and the next steps. That information is below. If you have any questions about the process - please give me a call. Thanks JB

(b) (5) CIP, passcode: (b) (5) CIP
-- see webinar information in the Description box below

This purpose of this webinar is to give an update on where we are with the Canada lynx recovery planning process.

Webinar information below:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

1. To join the meeting, copy and paste the following URL:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Ben Conard, Field Supervisor
U.S. Fish and Wildlife Service
Northern Idaho Field Office
11103 E. Montgomery Drive
Spokane Valley, WA 99206

Phone: (509) 893-8030
Fax: (509) 891-6748

--
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Phone: (509) 893-8030
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--
Dennis Mackey
Deputy State Supervisor
U.S. Fish and Wildlife Service
Boise, Idaho
Office: 208-378-5267
Cell: 208-860-1970

From: Michael Carrier
To: Kosterman, Megan
Subject: Re: [Update] Lynx SSA Coordination Call
Date: Tuesday, July 07, 2015 10:06:23 AM

Thanks.

Michael Carrier
Supervisor, U.S. Fish and Wildlife Service
Idaho Office

On Jul 7, 2015, at 9:04 AM, Kosterman, Megan <megan_kosterman@fws.gov> wrote:

> I am on the call right now, I will let you know if you miss anything important :-)
>
> On Tuesday, July 7, 2015, Michael Carrier <michael_carrier@fws.gov> wrote:
> > Just want to ensure one or both of you are on this call. I'm out of pocket today.
> >
> > Michael Carrier
> > Supervisor, U.S. Fish and Wildlife Service
> > Idaho Office
> >
> > Begin forwarded message:
> >
> > **From:** "Zelenak, Jim" <jim_zelenak@fws.gov>
> > **Date:** July 7, 2015 at 8:05:00 AM PDT
> > **To:** Michael Carrier <michael_carrier@fws.gov>, Megan Kosterman <megan_kosterman@fws.gov>, Lisa Solberg Schwab <lisa_solbergschwab@fws.gov>, Krishna Gifford <krishna_gifford@fws.gov>, Tara Nicolaysen <tara_nicolaysen@fws.gov>, Seth Willey <seth_willey@fws.gov>, Michelle Eames <michelle_eames@fws.gov>, Tom Chapman <tom_chapman@fws.gov>, Martin Miller <martin_miller@fws.gov>, Jennifer Szymanski <jennifer_szymanski@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Rollie White <rollie_white@fws.gov>, Jodi Bush <jodi_bush@fws.gov>, Tyler Abbott <tyler_abbott@fws.gov>, Anthony Tur <anthony_tur@fws.gov>, Karl Halupka <karl_halupka@fws.gov>, Leslie Ellwood <leslie_ellwood@fws.gov>, Bridget Fahey <bridget_fahey@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Heather Bell <heather_bell@fws.gov>, David Smith <drsmith@usgs.gov>, Kate Novak <kate_novak@fws.gov>, Jonathan Cummings <jwcummings@usgs.gov>, Laury Zicari <laury_zicari@fws.gov>, Ben Conard <ben_conard@fws.gov>, Dennis Mackey <dennis_mackey@fws.gov>, Mark Sattelberg <mark_sattelberg@fws.gov>, Brady McGee

<brady_mcgee@fws.gov>, Paul Casey <paul_casey@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Eric Hein <eric_hein@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Jessica Hogrefe <jessica_hogrefe@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Grant Canterbury <grant_canterbury@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Gary Miller <gary_miller@fws.gov>, Paul Henson <paul_henson@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>
Subject: Re: [Update] Lynx SSA Coordination Call

Hi All:

General agenda for today's call is:

1. Discuss coordination with States and other partners - Jodi's letter, talking points;

2. Planning for expert elicitation meeting in fall - location, venue, associated staff travel, etc.

3. Your questions/concerns.

Talk to you soon.

Jim

On Thu, Jun 25, 2015 at 3:28 PM, <jim_zelenak@fws.gov> wrote:

> Monthly Lynx SSA Coordination Call - July 7, 10-11 AM Mountain Time
>
> (b) (5) CIP
> (b) (5)
> CIP
>
> Webinar info to follow if needed.
>
> **Lynx SSA Coordination Call**
>
> When Tue Jul 7, 2015 10am – 11am Mountain Time
>
> Video call https://plus.google.com/hangouts/_/doi.gov/jim-zelenak
>
> Who • Jim Zelenak - organizer

--
Jim Zelenak, Biologist

U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

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Megan Kosterman
Endangered Species Biologist
U.S. Fish and Wildlife Service
Northern Idaho Field Office
11103 East Montgomery Drive
Spokane Valley, WA 99206
megan_kosterman@fws.gov
Office: 509-893-8013
Cell: 608-695-8492

From: Michael Carrier
To: Holt, Bryon
Subject: Re: [Update] Lynx SSA Coordination Call
Date: Tuesday, July 07, 2015 10:07:27 AM

Thanks

Michael Carrier
Supervisor, U.S. Fish and Wildlife Service
Idaho Office

On Jul 7, 2015, at 9:04 AM, Holt, Bryon <bryon_holt@fws.gov> wrote:

> Yes, both Megan and I are on.
>
> Bryon
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>> Just want to ensure one or both of you are on this call. I'm out of pocket today.
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Jonathan Cummings <jwcummings@usgs.gov>, Laury Zicari <laury_zicari@fws.gov>, Ben Conard <ben_conard@fws.gov>, Dennis Mackey <dennis_mackey@fws.gov>, Mark Sattelberg <mark_sattelberg@fws.gov>, Brady McGee <brady_mcgee@fws.gov>, Paul Casey <paul_casey@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Eric Hein <eric_hein@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Jessica Hogrefe <jessica_hogrefe@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Grant Canterbury <grant_canterbury@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Gary Miller <gary_miller@fws.gov>, Paul Henson <paul_henson@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>
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> Who
> - Jim Zelenak - organizer

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Jim Zelenak, Biologist
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Bryon Holt
U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

From: Zelenak, Jim
To: Michael Carrier; Megan Kosterman; Lisa Solberg Schwab; Krishna Gifford; Tara Nicolaysen; Seth Willey; Michelle Eames; Tom Chapman; Martin Miller; Jennifer Szymanski; Ann Belleman; Rollie White; Jodi Bush; Tyler Abbott; Anthony Tur; Karl Halupka; Leslie Ellwood; Bridget Fahey; Bryon Holt; Heather Bell; David Smith; Kate Novak; Jonathan Cummings; Laury Zicari; Ben Conard; Dennis Mackey; Mark Sattelberg; Brady McGee; Paul Casey; Sarah Hall; Mary Parkin; Eric Hein; Kurt Broderdorp; Jessica Hogrefe; Tamara Smith; Mark McCollough; Jeffrey Dillon; Jeff Krupka; Grant Canterbury; Mark Maghini; Gary Miller; Paul Henson; Jim Zelenak
Subject: Re: [Update] Lynx SSA Coordination Call
Date: Tuesday, July 07, 2015 11:05:03 AM

Hi All:

General agenda for today's call is:

1. Discuss coordination with States and other partners - Jodi's letter, talking points;

2. Planning for expert elicitation meeting in fall - location, venue, associated staff travel, etc.

3. Your questions/concerns.

Talk to you soon.

Jim

On Thu, Jun 25, 2015 at 3:28 PM, <jim_zelenak@fws.gov> wrote:

> Monthly Lynx SSA Coordination Call - July 7, 10-11 AM Mountain Time
>
> (b) (5) CIP
> (b) (5)
> CIP
>
> Webinar info to follow if needed.
>
> **Lynx SSA Coordination Call**
> When Tue Jul 7, 2015 10am – 11am Mountain Time
> Video call https://plus.google.com/hangouts/_/doi.gov/jim-zelenak
> Who • Jim Zelenak - organizer

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Belleman, Ann
To: Hogrefe, Jessica
Subject: Re: [Update] Lynx SSA Coordination Call
Date: Wednesday, July 08, 2015 10:17:13 AM

Hi Jessica,

Yes, but I'll be involved peripherally because Tam is the R3 rep for the SSA core team. However, I was the lynx "go-to" person in WY, so will provide assistance if needed to the person who filled in behind me. I took notes yesterday because Tam wasn't available and didn't know if anyone else would!

Ann

Ann Belleman
U.S. Fish and Wildlife Service
Minnesota/Wisconsin Field Office Complex
4101 American Blvd. E
Bloomington, MN 55425-1665

ann_belleman@fws.gov

307-421-5839 (work cell)
(612) 725-3548 (Bloomington, MN)

On Wed, Jul 8, 2015 at 10:37 AM, Hogrefe, Jessica <jessica_hogrefe@fws.gov> wrote:

> Hi Ann-
>
> I see that you are involved in this effort. I have not been able to participate much, but I want to stay in the loop and provide support as necessary. Please let me know when/how I can be of assistance.
>
> Thanks,
>
> .....
> **Jessica Hogrefe**
> USFWS, Region 3
> Division of Endangered Species
> 5600 American Blvd West, Suite 990
> Bloomington, MN 55437
> Phone: 612-713-5346

On Wed, Jul 8, 2015 at 9:22 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> Here are notes from yesterday's lynx SSA coordination call.
>
> Thanks very much to Ann Belleman for drafting these.
>
> Share with other FWS folks as needed.

Thanks,

Jim

On Tue, Jul 7, 2015 at 9:05 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> General agenda for today's call is:
>
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>
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>
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>
> Jim
>
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> > (b) (5) CIP
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> >
> > Who
> > - Jim Zelenak - organizer

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service

Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Michael Carrier; Megan Kosterman; Lisa Solberg Schwab; Michelle Eames; Tom Chapman; Martin Miller; Ann Belleman; Rollie White; Tyler Abbott; Anthony Tur; Karl Halupka; Leslie Ellwood; Bryon Holt; Kate Novak; Laury Zicari; Dennis Mackey; Mark Sattelberg; Brady McGee; Paul Casey; Sarah Hall; Eric Hein; Kurt Broderdorp; Jessica Hogrefe; Tamara Smith; Mark McCollough; Jeffrey Dillon; Jeff Krupka; Grant Canterbury; Mark Maghini; Gary Miller; Paul Henson; Wally Murphy
Cc:	Jennifer Szymanski; Tara Nicolaysen; Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; David Smith; Jonathan Cummings
Subject:	Re: [Update] Lynx SSA Coordination Call
Date:	Wednesday, July 08, 2015 10:23:05 AM
Attachments:	Lynx SSA Coordination Call Notes 07072015_final.docx

Hi All:

Here are notes from yesterday's lynx SSA coordination call.

Thanks very much to Ann Belleman for drafting these.

Share with other FWS folks as needed.

Thanks,

Jim

On Tue, Jul 7, 2015 at 9:05 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

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> > Who
> > - Jim Zelenak - organizer

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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Johnson, Kurt
Cc:	Bell, Heather; Seth Mott; Kate Freund; Seth Willey; Jodi Bush; Mary Parkin; David Smith; Jonathan Cummings; Jennifer Szymanski
Subject:	Re: Requesting assistance from FWS"s Science Applications regarding climate change, for the upcoming SSA on Lynx!
Date:	Thursday, July 09, 2015 12:22:23 PM

Thanks, Kurt.

I should have been specific about the call next Mon., July 13.

(b) (5) CIP, passcode: (b) (5) CIP

I will have my request better organized by then, but in short, we're working on reaching out to candidates for the lynx SSA expert elicitation meeting we plan to have Sept. - Oct., likely in Minneapolis, and we think we will need some climate modeling expertise. There are only a small handful of papers on lynx/CC (Carrol 2007; Gonzalez et al. 2007; the paper Kate co-authored with Kevin Johnston and Oswald Schmitz; also Stenseth et al 2004 [sort of]).

I think we will need someone who can help us translate and understand, possibly down-scale models to portray reasonably likely CC effects on boreal forest distribution and disturbance (fire/insects) regimes and snow conditions at its southern margin in the northern Lower-48, maybe southern Canada, too, over a couple time frames - maybe 40 & 80 or 50 & 100 years?

I also could use some help filtering and applying to lynx/hares/boreal forest the relevant info from the most recent IPCC and National Climate Assessment reports.

Anyway, hope you can joins us next Monday so we can discuss.

Thanks again,

Jim

On Thu, Jul 9, 2015 at 11:41 AM, Johnson, Kurt <kurt_johnson@fws.gov> wrote:

> Hey Jim,
>
> I could certainly be on the calls. Just send along the details. Anything more I can help with?
>
> Kurt
>
> On Thu, Jul 9, 2015 at 1:36 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Kurt,
> >
> > We have weekly lynx SSA calls on Mondays 11-12 Mountain Time/1-2 Eastern Time. Any chance you and/or Kate could dial in for that, or part of it?
> >
> > Let me know, and I'll shoot you the call-in info.

Thanks,

Jim

On Tue, Jul 7, 2015 at 8:40 AM, Johnson, Kurt <kurt_johnson@fws.gov> wrote:

Hi Heather and Jim,

I am happy to help as I can. Certainly a lot of relevant work has been done. The challenge will be making sense of it all! Would you like to schedule a call to get the ball rolling?

Kurt

On Tue, Jul 7, 2015 at 10:31 AM, Bell, Heather <heather_bell@fws.gov> wrote:

Kate, thanks so much this is excellent!
Kurt I assume we might hear from you soon? Feel free to connect with Jim Zelenak directly as he is the Lynx guy and has a good idea of what our needs are. Mary Parkin and I are assisting Jim in organizing the SSA process.
Much Appreciated and looking forward to working with Science Apps!

Heather Bell
Ecological Services HQ
Branch of Conservation Integration
SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the REV Google Site: https://sites.google.com/a/fws.gov/rev/

On Tue, Jul 7, 2015 at 6:57 AM, Freund, Kate <kate_freund@fws.gov> wrote:

Hi Heather,

Thanks for your email. Sounds like some very interesting questions - Kurt and I are talking to Seth about the best way that Science Applications can assist.

Are you all already working with Nancy Green on this? I imagine she would have some recommendations for relevant climate change information?

Thanks,

Kate

On Mon, Jul 6, 2015 at 2:49 PM, Bell, Heather <heather_bell@fws.gov> wrote:

Kate, given your programs climate change focus and your knowledge of the SSA Framework (you kindly reviewed and provided comments on the draft SSA Framework earlier this year) I am hoping you will be amenable to reviewing this request!

We are undertaking a Species Status Assessment for the Canadian Lynx in preparation for a 5-year review and, if applicable, recovery planning. The lead for the SSA, Jim Zelanak, believes that some assistance in understanding the effects of climate change on this wide ranging species would be critical in our assessment. We are struggling a bit on where the best place is to go for assistance given the many states this species (DPS) covers. Would you be willing to help us out either directly or in finding the best source for information?

Here is a short blurb Jim provided on the issue:

"Because the lynx is a boreal forest species reliant on snowshoe hares for food and persistent snow to out-compete other hare predators, we need to evaluate the potential effects of climate change on lynx populations within the DPS. We request your help in in identifying resources and experts who might best inform our evaluation of how climate warming may impact boreal forest habitats, including the size, intensity, and periodicity of forest fires and insect outbreaks, as well as snowshoe hare populations and abundances, and the distribution and persistence snow conditions favorable to lynx."

Thank you for your consideration of this request!

Heather Bell
Ecological Services HQ
Branch of Conservation Integration
SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the REV Google Site: https://sites.google.com/a/fws.gov/rev/

--
Kate Freund
Science Applications
U.S. Fish and Wildlife Service
703-358-2601

> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Paul Phifer
Cc: Martin Miller; Laury Zicari; Jim Zelenak
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Thursday, July 16, 2015 8:15:45 AM

Thanks Paul. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Wed, Jul 15, 2015 at 7:49 PM, Paul Phifer <paul_phifer@fws.gov> wrote:

> Sorry for the late response, Jodi. I'm on travel and will get to this
> on Friday.
>
> Paul Phifer
> USFWS
> 413-687-4764
>
> > On Jun 26, 2015, at 11:00 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > Attached is the final Lynx Project Plan for the SSA, Recovery Planning and
> > Five-year Review in both word and pdf format. I am requesting via this
> > email your signature on page 10 of that document. Comments on the draft
> > project plan were received in late April and early May and we have
> > incorporated those changes into the attached document.
> >
> > For ease of collating signatures please use any of the following methods to
> > add your signature to the document.
> >
> > 1. Open the attached pdf document in Adobe Reader. Click on the fill and
> > sign tab and make a selection for your signature of the document. *Save
> > and send back to Jim Zelenak.*
> >
> > 2. Sign a hardopy of the signature page (10), *scan and send back to Jim
> > Zelenak.*
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> > 3. Add your signature in the word document by adding * /s/ Your Name.* *Save
> > and send back to Jim Zelenak. *
> >
> >
> > You should have also received notice of what will be our monthly internal
> > FWS coordination calls on the process from Jim Zelanak.
> > We will be conducting these calls the first tuesday of every month at 10am
> > Mtn time.
> > Call in information is as follows (b) (5) CIP , passcode: (b) (5) CIP .

>
>
> Shortly I will also be sending out another letter for our state partners.
> As we know, the States are particularly interested in being engaged in our
> Lynx recovery planning process. To that end, the letter updates where we
> are now and identifies a monthly coordination call with our state partners
> to keep them appraised of our progress. It would be helpful if versions of
> this state letter were sent out from your offices. Please use the version
> I provide to you as a template.
>
> Thank you for your help and as always feel free to give me a call if you
> have questions or concerns. JB
>
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
> <2015 06 25 Proj Plan Canada Lynx SSA FINAL.pdf>
> <Signature Page Only_2015 06 25 Proj Plan Canada Lynx SSA FINAL.docx>
> <2015 06 25 Proj Plan Canada Lynx SSA FINAL.docx>

From:	Bush, Jodi
To:	Jim Zelenak
Subject:	Fwd: SIGNATURE NEEDED: Final Lynx Project Plan
Date:	Monday, July 20, 2015 3:03:24 PM
Attachments:	Signature Page Only_2015 06 25 Proj Plan Canada Lynx SSA FINAL.Phifer.docx

---

I don't know where we are on these but....JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

---------- Forwarded message ----------
From: **Phifer, Paul** <paul_phifer@fws.gov>
Date: Mon, Jul 20, 2015 at 2:52 PM
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
To: "Bush, Jodi" <jodi_bush@fws.gov>
Cc: Tom Chapman <tom_chapman@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Martin Miller <Martin_Miller@fws.gov>, Mary Parkin <mary_parkin@fws.gov>

Jodi - sorry this took me a while to get back to you. I appreciate the good coordination.

Paul

_____
Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.
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Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From: Bush, Jodi
To: Phifer, Paul
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, July 20, 2015 3:10:24 PM

---

no worries. Thanks Paul. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Jul 20, 2015 at 2:52 PM, Phifer, Paul <paul_phifer@fws.gov> wrote:

> Jodi - sorry this took me a while to get back to you. I appreciate the good coordination.
>
> Paul
>
> _____
> Paul Phifer, PhD
> Assistant Regional Director - Ecological Services
> Northeast Region
> Dept of the Interior
> US Fish and Wildlife Service
> 413.253.8698 work
> 413.687.4764 cell
>
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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From: Zelenak, Jim
To: Bush, Jodi
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Tuesday, July 21, 2015 7:15:34 AM

I did; forgot to download.

On Mon, Jul 20, 2015 at 3:47 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> did you not get this...? JB
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> ---------- Forwarded message ----------
> From: **Bush, Jodi** <jodi_bush@fws.gov>
> Date: Fri, Jul 10, 2015 at 2:49 PM
> Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
> To: "McGee, Brady" <brady_mcgee@fws.gov>
>
> thanks- JB
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Fri, Jul 10, 2015 at 2:37 PM, McGee, Brady <brady_mcgee@fws.gov> wrote:
>
> > Hi Jodi and Jim,
> >
> > Attached is R2's ARD signature on the Lynx Project Plan. Please let me know if you need anything else.
> >
> > Thanks,
> >
> > Brady
> >
> > ---
> > Brady McGee, Ph.D.
> > Chief, Branch of Recovery and Restoration
> > U.S. Fish and Wildlife Service
> > Southwest Regional Office

500 Gold Avenue SW, Rm 6042
Albuquerque, NM 87102
505-248-6657; cell 505-908-8491

On Wed, Jul 1, 2015 at 3:07 PM, McGee, Brady <brady_mcgee@fws.gov> wrote:

> Hi Michelle,
>
> I just spoke with Wally, and he said that he sent you a previous response saying he was okay with everything.
>
> Thanks,
>
> Brady
>
> ---
> Brady McGee, Ph.D.
> Chief, Branch of Recovery and Restoration
> U.S. Fish and Wildlife Service
> Southwest Regional Office
> 500 Gold Avenue SW, Rm 6042
> Albuquerque, NM 87102
> 505-248-6657; cell 505-908-8491
>
> On Fri, Jun 26, 2015 at 10:23 AM, Shaughnessy, Michelle <michelle_shaughnessy@fws.gov> wrote:
>
> > Before I sign it - can you folks make sure you are ok with the expectations and roles and responsibilities?
> >
> > On Fri, Jun 26, 2015 at 9:55 AM, Jacobsen, Susan <susan_jacobsen@fws.gov> wrote:
> >
> > > I have not been involved. Wally was lead in the past, but not sure if he was involved or aware of an SSA for recovery planning. He's out today.
> > >
> > > Brady, were you aware?
> > >
> > > On Fri, Jun 26, 2015 at 9:04 AM, Shaughnessy, Michelle <michelle_shaughnessy@fws.gov> wrote:
> > >
> > > > Susan and Wally - have you been involved in this?
> > > >
> > > > ---------- Forwarded message ----------
> > > > From: **Bush, Jodi** <jodi_bush@fws.gov>
> > > > Date: Fri, Jun 26, 2015 at 8:59 AM
> > > > Subject: SIGNATURE NEEDED: Final Lynx Project Plan
> > > > To: Eric Rickerson <eric_rickerson@fws.gov>, Michael Carrier <michael_carrier@fws.gov>, Mark Sattelberg <mark_sattelberg@fws.gov>, Ann Timberman <ann_timberman@fws.gov>, Drue DeBerry <drue_deberry@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Michael Thabault <michael_thabault@fws.gov>,

Theresa Rabot <theresa_rabot@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Michelle Shaughnessy <michelle_shaughnessy@fws.gov>, Lynn Lewis <lynn_lewis@fws.gov>, Wally Murphy <wally_murphy@fws.gov>
Cc: Jeff Krupka <Jeff_Krupka@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Seth Willey <seth_willey@fws.gov>, Kit Hershey <Kit_Hershey@fws.gov>, Sarah Quamme <Sarah_Quamme@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Krishna Gifford <krishna_gifford@fws.gov>, Eric Hein <Eric_Hein@fws.gov>

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You should have also received notice of what will be our monthly internal FWS coordination calls on the process from Jim Zelanak.
We will be conducting these calls the first tuesday of every month at 10am Mtn time.
Call in information is as follows: (b) (5) CIP passcode: (b) (5) CIP.

Shortly I will also be sending out another letter for our state partners. As we know, the States are particularly interested in being engaged in our Lynx recovery planning process. To that end, the letter updates where we are now and identifies a monthly coordination call with our state partners to keep them appraised of our progress. It would be helpful if versions of this state letter were sent out from your offices. Please use the version I provide to you as a template.

Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Michelle Shaughnessy
U.S. Fish and Wildlife Service - Southwest Region
Assistant Regional Director - Ecological Services
Office - 505-248-6671
Cell - 505-908-1151

Ecological Services achieves conservation of Service trust resources, focusing on imperiled species, through and with others.

--
Susan Jacobsen
Division Chief, Classification and Restoration
Ecological Services, Southwest Region
U.S. Fish and Wildlife Service
P.O. Box 1306, Albuquerque, NM 87103-1306
505-248-6641; mobile 505-206-9845

--
Michelle Shaughnessy
U.S. Fish and Wildlife Service - Southwest Region
Assistant Regional Director - Ecological Services
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Ecological Services achieves conservation of Service trust resources, focusing on imperiled species, through and with others.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Google Calendar
To:	kurt_broderdorp@fws.gov; jwcummings@usgs.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; bryon_holt@fws.gov; jim_zelenak@fws.gov; heather_bell@fws.gov; drsmith@usgs.gov; mary_parkin@fws.gov
Cc:	kurt_broderdorp@fws.gov; heather_bell@fws.gov; drsmith@usgs.gov; bryon_holt@fws.gov; jwcummings@usgs.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov; jim_zelenak@fws.gov
Subject:	[Update] Lynx SSA Core Team Call -- 10-11 MDT, 2nd and 4th Tuesdays of each month
Date:	Tuesday, July 28, 2015 9:08:07 AM

Just a reminder for today's call. Topics will include overview of tomorrow's State coordination call, expert selection criteria and current identified experts, availability and core team member roles for October workshop, and key questions for workshop.

Lynx SSA Core Team Call -- 10-11 MDT, 2nd and 4th Tuesdays of each month

Topics will include overview of State coordination call on 7/29, update on cardinal questions, and update on expert selection and EE workshop.

When Tue Jul 28, 2015 12pm – 1pm Eastern Time

Where (b) (5) CIP passcode(b) (5) (map)

Who
- Mary Parkin - organizer
- Seth Willey
- Kurt Broderdorp
- Heather Bell
- David Smith
- Bryon Holt
- Jonathan Cummings
- Mark McCollough
- Tamara Smith
- Jim Zelenak
- Jennifer Szymanski

From: Google Calendar

To: megan_kosterman@fws.gov; michael_carrier@fws.gov; lisa_solbergschwab@fws.gov; tara_nicolaysen@fws.gov; seth_willey@fws.gov; michelle_eames@fws.gov; tom_chapman@fws.gov; martin_miller@fws.gov; jennifer_szymanski@fws.gov; ann_belleman@fws.gov; rollie_white@fws.gov; jodi_bush@fws.gov; tyler_abbott@fws.gov; anthony_tur@fws.gov; karl_halupka@fws.gov; leslie_ellwood@fws.gov; bridget_fahey@fws.gov; bryon_holt@fws.gov; jim_zelenak@fws.gov; heather_bell@fws.gov; drsmith@usgs.gov; kate_novak@fws.gov; jwcummings@usgs.gov; laury_zicari@fws.gov; ben_conard@fws.gov; dennis_mackey@fws.gov; mark_sattelberg@fws.gov; brady_mcgee@fws.gov; paul_casey@fws.gov; sarah_hall@fws.gov; eric_hein@fws.gov; kurt_broderdorp@fws.gov; jessica_hogrefe@fws.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; jeffrey_dillon@fws.gov; jeff_krupka@fws.gov; grant_canterbury@fws.gov; mark_maghini@fws.gov; gary_miller@fws.gov; paul_henson@fws.gov; mary_parkin@fws.gov

Cc: jessica_hogrefe@fws.gov; jeffrey_dillon@fws.gov; tara_nicolaysen@fws.gov; tyler_abbott@fws.gov; paul_henson@fws.gov; kate_novak@fws.gov; megan_kosterman@fws.gov; seth_willey@fws.gov; drsmith@usgs.gov; bryon_holt@fws.gov; anthony_tur@fws.gov; ben_conard@fws.gov; jim_zelenak@fws.gov; tom_chapman@fws.gov; michael_carrier@fws.gov; rollie_white@fws.gov; mark_maghini@fws.gov; sarah_hall@fws.gov; jodi_bush@fws.gov; laury_zicari@fws.gov; ann_belleman@fws.gov; grant_canterbury@fws.gov; leslie_ellwood@fws.gov; martin_miller@fws.gov; gary_miller@fws.gov; jennifer_szymanski@fws.gov; bridget_fahey@fws.gov; paul_casey@fws.gov; mark_sattelberg@fws.gov; michelle_eames@fws.gov; dennis_mackey@fws.gov; eric_hein@fws.gov; kurt_broderdorp@fws.gov; heather_bell@fws.gov; lisa_solbergschwab@fws.gov; brady_mcgee@fws.gov; jwcummings@usgs.gov; karl_halupka@fws.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov; jeff_krupka@fws.gov

Subject: [Update] Lynx SSA - Coordination Call with States - July 29, 1 pm MDT

Date: Tuesday, July 28, 2015 5:40:31 PM

Please check your Google Calendar for this call, which will be our first with the States regarding the Canada lynx SSA. The call will begin with a presentation on the SSA process as applied to the lynx, (similar to the webinar presented on the July 7 FWS coordination call). We'll then conduct a "listening" session with State participants. The role of FWS folks on the call will be to listen in and, if needed, address particular questions raised by the States.

Jodi Bush is sending an email to State and FWS participants, along with the set of PowerPoint slides that will constitute the presentation.

Lynx SSA - Coordination Call with States - 1 pm MDT

First coordination call with States about lynx SSA. Will include webinar presentation of SSA framework and background for lynx SSA, discussion of State roles and expert selection/workshop, and possibly other topics, tbd. Webinar info and full guest list to follow.

When Wed Jul 29, 2015 3pm – 4:30pm Eastern Time

Where (b) (5) CIP , passcode (b) (5) (map)

Who
- Mary Parkin - organizer
- Jodi Bush
- Jennifer Szymanski
- Seth Willey
- Kurt Broderdorp
- Heather Bell
- David Smith
- Bryon Holt
- Jonathan Cummings
- Mark McCollough
- Tamara Smith
- Jim Zelenak

From: Parkin, Mary
To: megan_kosterman@fws.gov; michael_carrier@fws.gov; lisa_solbergschwab@fws.gov; Tara Nicolaysen; Seth Willey; michelle_eames@fws.gov; Tom Chapman; Martin Miller; Jennifer Szymanski; ann_belleman@fws.gov; Rollie White; Jodi Bush; Tyler Abbott; Anthony Tur; karl_halupka@fws.gov; leslie_ellwood@fws.gov; Bridget Fahey; Bryon Holt; Jim Zelenak; Heather Bell; David Smith; Kate Novak; Jonathan Cummings; Laury Zicari; ben_conard@fws.gov; dennis_mackey@fws.gov; mark_sattelberg@fws.gov; Brady McGee; paul_casey@fws.gov; Sarah Hall; Eric Hein; Kurt Broderdorp; Jessica Hogrefe; Tamara Smith; Mark McCollough; jeffrey_dillon@fws.gov; jeff_krupka@fws.gov; Grant Canterbury; Mark Maghini; gary_miller@fws.gov; paul_henson@fws.gov; Mary Parkin
Subject: Re: [Update] Lynx SSA - Coordination Call with States - July 29, 1 pm MDT
Date: Tuesday, July 28, 2015 6:59:13 PM

To clarify, everyone to whom this invitation is addressed is welcome to join the call. The initial invitation was a placeholder for the core team, and I didn't realize it would be part of today's invite.

Thanks,
Mary

On Tue, Jul 28, 2015 at 5:03 PM, <mary_parkin@fws.gov> wrote:

> Please check your Google Calendar for this call, which will be our first with the States regarding the Canada lynx SSA. The call will begin with a presentation on the SSA process as applied to the lynx, (similar to the webinar presented on the July 7 FWS coordination call). We'll then conduct a "listening" session with State participants. The role of FWS folks on the call will be to listen in and, if needed, address particular questions raised by the States.
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> Where (b) (5) CIP , passcode (b) (5) (map)
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> Who
> - Mary Parkin - organizer
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> - Kurt Broderdorp
> - Heather Bell
> - David Smith
> - Bryon Holt
> - Jonathan Cummings
> - Mark McCollough
> - Tamara Smith
> - Jim Zelenak

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Parkin, Mary
To: megan_kosterman@fws.gov; michael_carrier@fws.gov; lisa_solbergschwab@fws.gov; Tara Nicolaysen; Seth Willey; michelle_eames@fws.gov; Tom Chapman; Martin Miller; Jennifer Szymanski; ann_belleman@fws.gov; Rollie White; Jodi Bush; Tyler Abbott; Anthony Tur; karl_halupka@fws.gov; leslie_ellwood@fws.gov; Bridget Fahey; Bryon Holt; Jim Zelenak; Heather Bell; David Smith; Kate Novak; Jonathan Cummings; Laury Zicari; ben_conard@fws.gov; dennis_mackey@fws.gov; mark_sattelberg@fws.gov; Brady McGee; paul_casey@fws.gov; Sarah Hall; Eric Hein; Kurt Broderdorp; Jessica Hogrefe; Tamara Smith; Mark McCollough; jeffrey_dillon@fws.gov; jeff_krupka@fws.gov; Grant Canterbury; Mark Maghini; gary_miller@fws.gov; paul_henson@fws.gov; Mary Parkin
Subject: Re: [Update] Lynx SSA - Coordination Call with States - July 29, 1 pm MDT
Date: Tuesday, July 28, 2015 6:59:13 PM

To clarify, everyone to whom this invitation is addressed is welcome to join the call. The initial invitation was a placeholder for the core team, and I didn't realize it would be part of today's invite.

Thanks,
Mary

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>
> When Wed Jul 29, 2015 3pm – 4:30pm Eastern Time
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> Where (b) (5) CIP , passcode (b) (5) (map)
>
> Who
> - Mary Parkin - organizer
> - Jodi Bush
> - Jennifer Szymanski
> - Seth Willey
> - Kurt Broderdorp
> - Heather Bell
> - David Smith
> - Bryon Holt
> - Jonathan Cummings
> - Mark McCollough
> - Tamara Smith
> - Jim Zelenak

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Bush, Jodi
To: Sattelberg, Mark
Cc: Mary Parkin; Jim Zelenak
Subject: Re: Call in number for Lynx SSA call
Date: Wednesday, July 29, 2015 12:56:59 PM

---

we are using the call in number I provided in the letter.

(b) (5) Commerical Information

that is the number that was provided to the states. Thanks for checking. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Wed, Jul 29, 2015 at 11:59 AM, Sattelberg, Mark <mark_sattelberg@fws.gov> wrote:

> Jodi and Mary,
>
> Both of you have sent out the call-in number for this afternoon, however, they are not the same number. You might want to decide which one to use and let folks know it.
>
> Mary sent: (b) (5) CIP passcode (b) (5)
> Jodi sent: (b) (5) Commerical Information
> ---
> R. Mark Sattelberg
> Field Supervisor
> U.S. Fish and Wildlife Service
> Wyoming Ecological Services Field Office
> 5353 Yellowstone Boulevard, Suite 308A
> Cheyenne, Wyoming 82009
>
> Phone: 307.772.2374 ext.234
> Cell Phone: 307.631.8186
> Fax: 307.772.2358
> mark_sattelberg@fws.gov

From: Bush, Jodi
To: Sattelberg, Mark
Cc: Mary Parkin; Jim Zelenak
Subject: Re: Call in number for Lynx SSA call
Date: Wednesday, July 29, 2015 12:56:59 PM

---

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Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

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>
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> Jodi sent: (b) (5) Commerical Information
> ---
> R. Mark Sattelberg
> Field Supervisor
> U.S. Fish and Wildlife Service
> Wyoming Ecological Services Field Office
> 5353 Yellowstone Boulevard, Suite 308A
> Cheyenne, Wyoming 82009
>
> Phone: 307.772.2374 ext.234
> Cell Phone: 307.631.8186
> Fax: 307.772.2358
> mark_sattelberg@fws.gov

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: [Update] Lynx SSA - Coordination Call with States - July 29, 1 pm MDT
Date: Wednesday, July 29, 2015 2:20:14 PM

---

thanks Jim. I forwarded Jody's email to state wildlife agency folks at ME, VT, and NH. I still don't have a good contact with NY - I have not corresponded with them on lynx in the past. Mark

On Wed, Jul 29, 2015 at 2:18 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> To Clarify and avoid confusion - the call in information for State coordination call at 1 PM Mountain Time is:
>
> (b)(5)CIP
>
> passcode: (b)
>
> Do not use the number in the box below.
>
> Jim
>
> On Tue, Jul 28, 2015 at 3:03 PM, <mary_parkin@fws.gov> wrote:
>
> > Please check your Google Calendar for this call, which will be our first with the States regarding the Canada lynx SSA. The call will begin with a presentation on the SSA process as applied to the lynx, (similar to the webinar presented on the July 7 FWS coordination call). We'll then conduct a "listening" session with State participants. The role of FWS folks on the call will be to listen in and, if needed, address particular questions raised by the States.
> >
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> > **Lynx SSA - Coordination Call with States - 1 pm MDT**
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> > When Wed Jul 29, 2015 3pm – 4:30pm Eastern Time
> >
> > Where (b) (5) CIP , passcode (b) (5) (map)
> >
> > Who
> > - Mary Parkin - organizer
> > - Jodi Bush
> > - Jennifer Szymanski
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> > - Kurt Broderdorp
> > - Heather Bell
> > - David Smith
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> > - Mark McCollough
> > - Tamara Smith

- Jim Zelenak

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Murphy, Wally
To: Zelenak, Jim
Subject: Re: Reminder - Lynx SSA Coordination Call
Date: Tuesday, August 04, 2015 8:51:12 AM

Jim it looks like you have the right people on the list-wm

On Tue, Aug 4, 2015 at 8:48 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> Internal FWS Lynx SSA coordination call today at 10 AM Mountain Time.
>
> (b) (5) CIP
> Passcode: (b) (5)
>
> I anticipate a short call to update folks on last week's State coordination call, discuss planning for the expert elicitation meeting this fall, and see if folks have questions.
>
> Attached is the draft list of candidates for the expert elicitation meeting that the core team has been working on. We have reached out informally to most to gauge their interest and availability for a meeting this fall (mid-Oct. to mid-Nov.). We will share a different version of this list with our State partners soon to solicit their input. Kurt Johnson with Science Applications at HQ is helping out with potential climate change experts, and the core team will work with him soon to narrow the list of potential climate change modeling folks who might attend the expert workshop.
>
> Talk to you soon.
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Wally Murphy
NMESFO Supervisor
505/761-4781
CP 505/480-4821
"We are what we repeatedly do. **Excellence** then, is not an act, but a habit." Aristotle

From: Belleman, Ann
To: Tamara Smith
Subject: Fwd: Reminder - Lynx SSA Coordination Call
Date: Tuesday, August 04, 2015 9:34:29 AM
Attachments: 2015 07 27 Lynx SSA Expert Workshop Candidates.docx

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Hi Tam,

According to your schedule, it looks like you're working today so will be available for this update call at 11 am CT.

I'm trying to figure out how best to integrate with the lynx SSA as a non-core team person and ex-WY lynx bio. For e.g., should I call in today ... is there a need for me to help with the expert elicitation meeting in the fall (behind the scenes organizational stuff) ... etc. I called Lisa and left her a message asking these questions and whether I should just coordinate with you and/or her, etc.

Any thoughts?

Ann Belleman
U.S. Fish and Wildlife Service
Minnesota/Wisconsin Field Office Complex
4101 American Blvd. E
Bloomington, MN 55425-1665

ann_belleman@fws.gov

307-421-5839 (work cell)
(612) 725-3548 (Bloomington, MN)

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Tue, Aug 4, 2015 at 9:48 AM
Subject: Reminder - Lynx SSA Coordination Call
To: Drue DeBerry <drue_deberry@fws.gov>, Michael Carrier <michael_carrier@fws.gov>, Laury Zicari <Laury_Zicari@fws.gov>, Scott Hicks <scott_hicks@fws.gov>, Peter Fasbender <peter_fasbender@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Wally Murphy <wally_murphy@fws.gov>, David Stilwell <David_Stilwell@fws.gov>, Paul Henson <paul_henson@fws.gov>, Larry Crist <Larry_Crist@fws.gov>, Eric Rickerson <eric_rickerson@fws.gov>, Mark Sattelberg <Mark_Sattelberg@fws.gov>
Cc: Jodi Bush <jodi_bush@fws.gov>, Heather Bell <heather_bell@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, David Smith <drsmith@usgs.gov>, Jonathan Cummings <jwcummings@usgs.gov>, Ann Timberman <ann_timberman@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Leslie Ellwood <leslie_ellwood@fws.gov>, Seth Willey <seth_willey@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Megan Kosterman <megan_kosterman@fws.gov>, Kim Garner <kim_garner@fws.gov>, Steve Duke <steve_duke@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Martin Miller <Martin_Miller@fws.gov>, Chris Mensing <chris_mensing@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Jessica Hogrefe

<Jessica_Hogrefe@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Paul Casey <paul_casey@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Eric Hein <Eric_Hein@fws.gov>, Brady McGee <brady_mcgee@fws.gov>, Rollie White <rollie_white@fws.gov>, Gary Miller <gary_miller@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Grant Canterbury <Grant_Canterbury@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Sue Livingston <sue_livingston@fws.gov>, Kate Novak <kate_novak@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Michelle Eames <michelle_eames@fws.gov>, Karl Halupka <Karl_Halupka@fws.gov>, Tyler Abbott <Tyler_Abbott@fws.gov>, Lisa Solberg Schwab <lisa_solbergschwab@fws.gov>, Kurt Johnson <kurt_johnson@fws.gov>

Hi All:

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(b) (5) CIP
Passcode: (b) (5)

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Talk to you soon.

Jim

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Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Drue DeBerry; Michael Carrier; Laury Zicari; Scott Hicks; Peter Fasbender; Tom Chapman; Wally Murphy; David Stilwell; Paul Henson; Larry Crist; Eric Rickerson; Mark Sattelberg
Cc:	Jodi Bush; Heather Bell; Mary Parkin; David Smith; Jonathan Cummings; Ann Timberman; Kurt Broderdorp; Leslie Ellwood; Seth Willey; Bryon Holt; Megan Kosterman; Kim Garner; Steve Duke; Mark McCollough; Martin Miller; Chris Mensing; Lisa Mandell; Tamara Smith; Ann Belleman; Laura Ragan; Jessica Hogrefe; Anthony Tur; Paul Casey; Mark Maghini; Eric Hein; Brady McGee; Rollie White; Gary Miller; Jeffrey Dillon; Grant Canterbury; Sarah Hall; Sue Livingston; Kate Novak; Jeff Krupka; Michelle Eames; Karl Halupka; Tyler Abbott; Lisa Solberg Schwab; Kurt Johnson
Subject:	Reminder - Lynx SSA Coordination Call
Date:	Tuesday, August 04, 2015 10:48:40 AM
Attachments:	2015 07 27 Lynx SSA Expert Workshop Candidates.docx

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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Smith, Tamara
To: Belleman, Ann
Subject: Re: Reminder - Lynx SSA Coordination Call
Date: Tuesday, August 04, 2015 10:54:44 AM

Hi Ann - Good questions. I think you should talk it over with Lisa, but it is probably a good idea to be on these monthly all FWS calls - since you are most in tune with what is going on in the MN/WI Nat'l Forests. I'm not entirely clear who the intended audience/participants are for these monthly calls, however...I assumed it was any interested FWS person who deals with lynx issues and who wants to stay in tune with what the core team is doing, the SSA, etc.

Jim hasn't talked to me yet about the expert elicitation meeting in terms of logistics and behind the scenes coordination. I'll let you know if Jim requests some help. I'm pretty sure it will be scheduled for the week of Oct. 13th.

Thanks,
Tam

On Tue, Aug 4, 2015 at 10:34 AM, Belleman, Ann <ann_belleman@fws.gov> wrote:

> Hi Tam,
>
> According to your schedule, it looks like you're working today so will be available for this update call at 11 am CT.
>
> I'm trying to figure out how best to integrate with the lynx SSA as a non-core team person and ex-WY lynx bio. For e.g., should I call in today ... is there a need for me to help with the expert elicitation meeting in the fall (behind the scenes organizational stuff) ... etc. I called Lisa and left her a message asking these questions and whether I should just coordinate with you and/or her, etc.
>
> Any thoughts?
>
> Ann Belleman
> U.S. Fish and Wildlife Service
> Minnesota/Wisconsin Field Office Complex
> 4101 American Blvd. E
> Bloomington, MN 55425-1665
>
> ann_belleman@fws.gov
>
> 307-421-5839 (work cell)
> (612) 725-3548 (Bloomington, MN)
>
> ---------- Forwarded message ----------
> From: **Zelenak, Jim** <jim_zelenak@fws.gov>
> Date: Tue, Aug 4, 2015 at 9:48 AM
> Subject: Reminder - Lynx SSA Coordination Call
> To: Drue DeBerry <drue_deberry@fws.gov>, Michael Carrier <michael_carrier@fws.gov>,

Laury Zicari <Laury_Zicari@fws.gov>, Scott Hicks <scott_hicks@fws.gov>, Peter Fasbender <peter_fasbender@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Wally Murphy <wally_murphy@fws.gov>, David Stilwell <David_Stilwell@fws.gov>, Paul Henson <paul_henson@fws.gov>, Larry Crist <Larry_Crist@fws.gov>, Eric Rickerson <eric_rickerson@fws.gov>, Mark Sattelberg <Mark_Sattelberg@fws.gov>
Cc: Jodi Bush <jodi_bush@fws.gov>, Heather Bell <heather_bell@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, David Smith <drsmith@usgs.gov>, Jonathan Cummings <jwcummings@usgs.gov>, Ann Timberman <ann_timberman@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Leslie Ellwood <leslie_ellwood@fws.gov>, Seth Willey <seth_willey@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Megan Kosterman <megan_kosterman@fws.gov>, Kim Garner <kim_garner@fws.gov>, Steve Duke <steve_duke@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Martin Miller <Martin_Miller@fws.gov>, Chris Mensing <chris_mensing@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Jessica Hogrefe <Jessica_Hogrefe@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Paul Casey <paul_casey@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Eric Hein <Eric_Hein@fws.gov>, Brady McGee <brady_mcgee@fws.gov>, Rollie White <rollie_white@fws.gov>, Gary Miller <gary_miller@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Grant Canterbury <Grant_Canterbury@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Sue Livingston <sue_livingston@fws.gov>, Kate Novak <kate_novak@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Michelle Eames <michelle_eames@fws.gov>, Karl Halupka <Karl_Halupka@fws.gov>, Tyler Abbott <Tyler_Abbott@fws.gov>, Lisa Solberg Schwab <lisa_solbergschwab@fws.gov>, Kurt Johnson <kurt_johnson@fws.gov>

Hi All:

Internal FWS Lynx SSA coordination call today at 10 AM Mountain Time.

(b) (5) CIP
Passcode: (b) (5)

I anticipate a short call to update folks on last week's State coordination call, discuss planning for the expert elicitation meeting this fall, and see if folks have questions.

Attached is the draft list of candidates for the expert elicitation meeting that the core team has been working on. We have reached out informally to most to gauge their interest and availability for a meeting this fall (mid-Oct. to mid-Nov.). We will share a different version of this list with our State partners soon to solicit their input. Kurt Johnson with Science Applications at HQ is helping out with potential climate change experts, and the core team will work with him soon to narrow the list of potential climate change modeling folks who might attend the expert workshop.

Talk to you soon.

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service

Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
612-725-3548 ext. 2219
612-600-1599 cell

From: Sue Livingston
To: Jim Zelenak
Subject: RE: Reminder - Lynx SSA Coordination Call
Date: Tuesday, August 04, 2015 11:03:19 AM

Hi Jim,
Would you please pass along the pdf you presented at last week's state coordination meeting? Thanks much.

Also, in response to the conversation on today's call regarding keeping track of the admin record and FOIA type documents, wanted to pass along what we have been doing for the west coast fisher DPS listing evaluation. We created an email account to which the core team ccs all emails that would be considered part of the record. Of course, the key is that everybody actually does this throughout the process; speaking for myself, I was pretty religious about doing so the first few months, but now I'm not so consistent (same story for many others on the team). However, the one advantage is that when it comes time to compile the record, as I scan through my emails I will know that all those that were sent to the fisher email address are already part of the record and don't need to be provided, so I can weed those out quickly. The downside is that somebody in the fisher lead office will have to pore through all the emails in the fisher account to organize them, whereas some of that organization might otherwise have occurred by the originating office. Anyway, something to consider.
Sue

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, August 04, 2015 7:49 AM
To: Drue DeBerry; Michael Carrier; Laury Zicari; Scott Hicks; Peter Fasbender; Tom Chapman; Wally Murphy; David Stilwell; Paul Henson; Larry Crist; Eric Rickerson; Mark Sattelberg
Cc: Jodi Bush; Heather Bell; Mary Parkin; David Smith; Jonathan Cummings; Ann Timberman; Kurt Broderdorp; Leslie Ellwood; Seth Willey; Bryon Holt; Megan Kosterman; Kim Garner; Steve Duke; Mark McCollough; Martin Miller; Chris Mensing; Lisa Mandell; Tamara Smith; Ann Belleman; Laura Ragan; Jessica Hogrefe; Anthony Tur; Paul Casey; Mark Maghini; Eric Hein; Brady McGee; Rollie White; Gary Miller; Jeffrey Dillon; Grant Canterbury; Sarah Hall; Sue Livingston; Kate Novak; Jeff Krupka; Michelle Eames; Karl Halupka; Tyler Abbott; Lisa Solberg Schwab; Kurt Johnson
Subject: Reminder - Lynx SSA Coordination Call

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might attend the expert workshop.

Talk to you soon.

Jim

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Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Lynx SSA Core Team Call
Date: Tuesday, August 11, 2015 11:13:44 AM

Hi Team,

Mary, Heather, and Tam are all at the R3 SSA Workshop and so unable to attend. However, I'd like to have a brief call with the rest of you at our usual time (these are still not showing up on my Google calendar - yours?).

Anyway, 10 AM Mountain time, 9 AM Pacific, and noon eastern.

(b) (5) CIP
pass: (b) (5)

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Holt, Bryon
To: Chan, Jeffrey; Jeff Krupka
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Thursday, August 20, 2015 1:13:44 PM

Jeff and Jeff,

Thanks for bird dogging this for me!

Bryon

On Thu, Aug 20, 2015 at 1:12 PM, Chan, Jeffrey <jeffrey_chan@fws.gov> wrote:

> Talked to Brad and he said he is out of the loop on this one. He said Eric and Tom are both out for the rest of the week, but I have forwarded Bryon's email with attachments to both of them prompting that we need FO signature for the Project Plan.
>
> Jeff Chan (Fish Biologist)
> Listing & Recovery Division
> U.S. Fish & Wildlife Service
> Washington Fish and Wildlife Office
> 510 Desmond Drive SE, Suite 102
> Lacey, Washington 98503-1263
> Phone: (360) 753-9542 Fax: (360) 753-9008
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> On Thu, Aug 20, 2015 at 1:07 PM, Krupka, Jeff <jeff_krupka@fws.gov> wrote:
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> > Jeff Krupka, Supervisory Fish and Wildlife Biologist
> > USFWS - Central Washington Field Office
> > 215 Melody Lane, Suite 103
> > Wenatchee, WA 98801-8122
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> > 509.665.3509 (fax)
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> > On Thu, Aug 20, 2015 at 1:01 PM, Chan, Jeffrey <jeffrey_chan@fws.gov> wrote:
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> > >
> > > > I'll check in with Lacey again. Sorry I don't have a better answer for you.
> > > >
> > > > Jeff Krupka, Supervisory Fish and Wildlife Biologist
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On Thu, Aug 20, 2015 at 12:53 PM, Holt, Bryon <bryon_holt@fws.gov> wrote:

> Hi Jeff,
>
> Sorry to keep pressing you on this, but do you know if Eric has signed these docs? If they have been signed, could I receive signed copy?
>
> Thanks,
>
> Bryon
>
> ---------- Forwarded message ----------
> From: **Krupka, Jeff** <jeff_krupka@fws.gov>
> Date: Tue, Jul 28, 2015 at 10:18 AM
> Subject: Fwd: SIGNATURE NEEDED: Final Lynx Project Plan
> To: Jeffrey Chan <jeffrey_chan@fws.gov>
> Cc: Bryon Holt <bryon_holt@fws.gov>, Karl Halupka <karl_halupka@fws.gov>
>
> Jeff: do you know if Eric signed these? Thanks, jk
>
> Jeff Krupka, Supervisory Fish and Wildlife Biologist
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> To: Jeff Krupka <Jeff_Krupka@fws.gov>, Karl Halupka <karl_halupka@fws.gov>
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From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Fri, Jun 26, 2015 at 7:59 AM
Subject: SIGNATURE NEEDED: Final Lynx Project Plan
To: Eric Rickerson <eric_rickerson@fws.gov>, Michael Carrier <michael_carrier@fws.gov>, Mark Sattelberg <mark_sattelberg@fws.gov>, Ann Timberman <ann_timberman@fws.gov>, Drue DeBerry <drue_deberry@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Michael Thabault <michael_thabault@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Lisa Mandell <lisa_mandell@fws.gov>, Michelle Shaughnessy <michelle_shaughnessy@fws.gov>, Lynn Lewis <lynn_lewis@fws.gov>, Wally Murphy <wally_murphy@fws.gov>
Cc: Jeff Krupka <Jeff_Krupka@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Ann Belleman <ann_belleman@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Seth Willey <seth_willey@fws.gov>, Kit Hershey <Kit_Hershey@fws.gov>, Sarah Quamme <Sarah_Quamme@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Krishna Gifford <krishna_gifford@fws.gov>, Eric Hein <Eric_Hein@fws.gov>

Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.

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We will be conducting these calls the first tuesday of every month at 10am Mtn time.
Call in information is as follows: (b) (5) CIP passcode: (b) (5) CIP.

Shortly I will also be sending out another letter for our state partners. As we know,

the States are particularly interested in being engaged in our Lynx recovery planning process. To that end, the letter updates where we are now and identifies a monthly coordination call with our state partners to keep them appraised of our progress. It would be helpful if versions of this state letter were sent out from your offices. Please use the version I provide to you as a template.

Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

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****
Bryon Holt
U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

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Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

From: Holt, Bryon
To: Zelenak, Jim
Subject: Re: Lynx SSA Core Team Call
Date: Monday, August 24, 2015 3:34:01 PM

It's showing on my calendar.

On Mon, Aug 24, 2015 at 2:17 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Gang,
>
> Sorry these are apparently not showing up on your google calendars yet, but I hope you can call in tomorrow at the usual time (10-11 Mountain Time) and numbers.
>
> Call-in: (b) (5) CIP
> Passcode: (b) (5)
>
> Talk to you then!
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
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email: bryon_holt@fws.gov

****

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Lynx SSA Core Team Call
Date: Monday, August 24, 2015 5:17:04 PM

Hi Gang,

Sorry these are apparently not showing up on your google calendars yet, but I hope you can call in tomorrow at the usual time (10-11 Mountain Time) and numbers.

Call-in: (b) (5) commercial information (b) (5) commercial information (b) (5) commercial information
Passcode: (b) (5) commercial (b) (5) commercial

Talk to you then!

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Mary Parkin; Heather Bell; Jodi Bush; Seth Willey; Jonathan Cummings
Subject: Lynx call
Date: Monday, September 21, 2015 5:11:18 AM

I'm at NCTC for Recovery class.

Lunch is scheduled for 12:15 Eastern Time, and I believe we agreed that we'd try to have the SSA FIT call then. I'llk try to find a room or call from my cell.

Same numbers as usual:

(b) (5) CIP
(b) (5)

We'll see how this goes and, if well, I'll email CORE Team later to set up that call for tomorrow.

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: McCollough, Mark
To: Laury Zicari
Subject: Lynx call at noon today
Date: Monday, October 05, 2015 11:01:46 AM

Laury:

My cell phone does not work here. I've tried calling you this morning and left you a message. Your calendar says that you are at a MEDOT meeting.

Given the turn of events relating to Maine, you are welcome to join our lynx core team call at noon today. I suspect that Jodi Bush will be on the call given similar last-minute events from the State of Montana.

This is the call-in number that we usually use: Phone (b) (5) CIP Passcode (b) (5) If there is anything different I will email.

It will be a great loss if Dan does not attend the meeting. I don't know if it would help if you called Dan. I could do the same, but want to hear what is discussed at noon.

Knowing that not all the experts can "present" at the meeting next week, I asked Dan and Erin to represent Jen's research as appropriate and to please give the State credit for whatever data are presented. They were both very willing to do this.

I am concerned about could be presented by MDIFW next week. I went over Dan and Erin's data with them last week so understood what would have been presented. I will have no idea what will be presented by MDIFW or their latest interpretations. I don't want to be in the position of being caught off guard and having to contest experimental design of studies and interpretations of lynx status opposite to those the Service believes represent the best available science.

You may want to be part of the call at noon - our last before next week's meeting.

Mark

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Zelenak, Jim
To: McCollough, Mark
Cc: Bush, Jodi; Laury Zicari
Subject: Re: Agenda and other materials for lynx workshop
Date: Monday, October 05, 2015 12:54:23 PM

Thanks, Mark.

We do have an implementation team call at 11 Mountain Time (Mary, Heather, Jonathan Cummings) and I will let them know about the Maine issue. Feel free to join that call if you'd like to discuss Dan and Jen, etc..

(b) (5) CIP , passcode: (b) (5)

On Mon, Oct 5, 2015 at 10:16 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Jodi:
>
> Thank you for sharing the information.
>
> I am disappointed that MDIFW did not contact Laury and I and instead went through other channels. Its somewhat helpful to hear that we are not the only state with these concerns.
>
> I had no idea that the State or Dan would react this way. In retrospect, perhaps I should have brought all 3 individuals together last week and developed a joint presentation. However, none of us had the time to do so. I truly thought that Dan would be the best presenter since he had the most experience and peer-reviewed publications. I know Dan well enough that he would have been diplomatic about presenting any information that came from the State.
>
> I will try calling Dan this afternoon (I forgot that our call is tomorrow, Tuesday, not today!).
>
> I hope things will go smoother next week.
>
> Mark
>
> On Mon, Oct 5, 2015 at 11:39 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
>
> > Mark. I realize that the shortened time frame for the agenda, meeting notice and subsequent products is frustrating for everyone. However, we have a timeline that we are required to meet and a process that we have been asked to use and state partners that we have agreed to bring into the process. We will do the best we can to meet those commitments - even when we are faced with controversy within states between academia and state science.
> >
> > Lets not give up on Dan until you have talked to him and we feel like he will not change his mind.
> >
> > Paul Phifer is also aware of the situation as it was due to Jim Connelly's discussion with him that we decided to allow Jennifer to present the states information after Dan. In retrospect perhaps we should have talked to Dan before just moving forward with that on the agenda.
> >
> > In any case, thank you for working with Maine to figure this out. Be assured that you are

not the only state with these types of issues. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Oct 5, 2015 at 9:23 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

Jim:

I think that Erin could present the Maine summary. If that is the case, I request that Jen present first and Erin last. I know that Dan spent considerable time on the Maine presentation last week. I spent 2 hours with him and subsequently sent a number of figures, maps, etc. for the presentation. I hope he would share the presentation he prepared with Erin.

I have not called Dan, and may call him after our call at noon to see where things stand.

I was not aware of the deepness of the dispute, and was surprised by the reaction of Jen last week and Dan today. Dan is not always in agreement with the scientific rigor and interpretations that the State has produced - published and unpublished. The State has sometimes opposed and discounted the UMaine research, even the conclusions of peer-reviewed publications on which the State biologists were coauthors. Likewise, the Service had concerns about some of the interpretations of lynx and hare status, home range, and habitat needs presented in the State's trapping HCP.

Having met with both Dan and Erin last week, I was comfortable with the scientific integrity of the information they would have presented. I will have no opportunity to preview what the State will present.

This is unfortunate.

Mark

On Mon, Oct 5, 2015 at 11:01 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

Thanks, Mark.

Dan called me just before his email arrived and I didn't have a chance to read it until after he hung up. Sounded like his mind was made up, though I tried to explain many of the same things you did in your email reply to him. It would be nice to give every researcher all the time needed to describe each research effort, but that could take a whole week and we'd never get to the elicitation part of it.

I hope he will reconsider, but I'm doubtful. Guess I didn't understand the depth of the divide between the university and the state. If nothing else, it may have opened a spot on the agenda for Erin - do you think she would be agreeable to contributing to the Maine population update presentation?

On Mon, Oct 5, 2015 at 8:31 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Dan:
>
> I ask that you please re-consider...
>
> The expert elicitation meeting is meant to be an ongoing discussion of lynx/hare ecology throughout the DPS. Although the agenda reflects a series of presentations, it is not supposed to be a conference - it is designed to be a dialogue. Your input is greatly needed. Lynx/hare ecology has similarities, but there are significant differences throughout their range, particularly as it pertains to Maine.
>
> Given your 15 years of experience, you are recognized as a lynx/hare expert for the Northeast. No one has better peer-reviewed data and publication record, which is why the USFWS asked you to prepare the Maine presentation. We really want you to be present and be able to discuss the research results from Maine - much of which the Service funded along with forest industry. Your absence would be a great loss to our expert elicitation process. Our process is dependent on the best available science. Please reconsider.
>
> Having worked in a state agency and taught wildlife policy, I think you can understand the difficult political position that the USFWS is in trying to balance state interests with our task of developing a lynx recovery plan. The "best" available science should be apparent. The group of scientists assembled can ask critical questions and should be able to assess the rigor and quality of the information presented. I know that you pride yourself for being true to the scientific process, and that will be apparent.
>
> I have expressed my concerns to Jim about the differences of opinion concerning USFWS, State, and UMaine concerning the status of lynx, hares, and their habitat in Maine. I had hoped that we could discuss these differences in a professional manner.
>
> I am in a difficult position. You know how I feel about the science and the quality of your work. However, as a core member of the USFWS team, I have limited ability to be involved in the discussion, and although I feel qualified to represent your (our) research, I cannot make the Maine presentation. Nor could I begin to represent your depth of knowledge on the subject. You truly are our expert.
>
> Thus, as a friend and colleague, I would ask that you please reconsider. Perhaps Jim can talk to you as he did with Jen last Friday.
>
> Thank you, Mark

On Mon, Oct 5, 2015 at 10:09 AM, Daniel Harrison <harrison@maine.edu> wrote:

> 5 October 2015
>
> Dear Jim,

This morning I received the agenda for the expert elicitation workshop and the phone message that you sent on Friday afternoon 10/2. I was asked verbally to attend as the invited expert representing Maine sometime in August and have been juggling to fit this important meeting into an October agenda that includes 3 other out-of-state trips, including a 3-day trip to Hadley, MA to work with FWS on our collaborative forest bird project, and a myriad of university deadlines --- while also serving as Chair of a growing academic department. I have been working to compile science updates for Maine lynx population based on 7 graduate theses, 7 refereed publications, and 6 papers *in prep* that address the first empirical data on long-term trends in hare populations in Maine's Acadian forests, reliance of hare in southern populations during periods of high and low hare density, social, behavioral and habitat responses of lynx to shifting hare densities, and historical and current distributional changes of lynx in Maine. My topical approach was based on a long list of items that I was asked to cover in previous e-mails and discussions and via meetings with with FWS biologists associated with lynx conservation.

Based on your phone call and draft agenda, the presentation on eastern lynx populations, which represent the vast majority of lynx occurring in the coterminous 48 states, is allotted only 1/7th of the agenda for population status updates. There also is no time scheduled for a discussion of hare populations in the eastern portion of the DPS. Furthermore, your phone message received this morning indicates that you now want me to split the Maine presentation with another invited expert representing the Maine Department of Inland Fisheries and Wildlife. You have further requested that I work to dovetail my presentation with that speaker. I am leaving tomorrow for another FWS workshop and would not have another day in the office prior to departing for the lynx meeting, so that will not be practical. This is also a difficult request given that MDIFW has repeatedly expressed a politically-based agenda to have eastern lynx listed as a separate DPS and for that new DPS to be de-listed based on unpublished, non-peer reviewed science. The peer-reviewed science from my lab has been consistently refuted by that agency based on inconvenient results that run contrary to that agenda. Thus, condensing my presentation to 15 minutes on short notice and asking me to integrate my science-based talk with the unpublished and non-peer reviewed data that has not been shared with me is untenable. I also do not wish to get involved in an open debate of the value of peer-reviewed science versus non-peer reviewed observations at a scientific meeting.

Regretfully, I have decided not to attend the Lynx SSA Expert Solicitation Workshop. My decision is based on the fact that there would be redundancy with 4 invited experts present from Maine, the late notice of the agenda does not allow me to meet your requests given my competing timelines, and the exceptionally brief opportunity to share eastern findings does not warrant 4 days out of office. Further, the likely presence of a political agenda in what had been described to me as a science-based meeting will likely be counter-productive. Those political discussions occur via many venues and I thought this meeting was intended to be science-based. Most importantly, a fifteen minute opportunity to share 2 decades of research, and which would required 4 days out of office, including travel, does not fit into a schedule dominated by a host of other research and university deadlines.

Obviously, I have numerous concerns with how this meeting has been planned and the poor and untimely communication with experts representing the eastern portion of the DPS. Regardless, I wish you all a productive meeting and hope that the outcomes can contribute is some way to lynx conservation and recovery.

Sincerely,

Dan Harrison

Daniel J. Harrison
Professor and Chair - Department of Wildlife, Fisheries, and Conservation Biology
Cooperating Professor of Sustainable Forestry
The University of Maine
5755 Nutting Hall, Room 210
Orono, ME 04469-5755
(207) 581-2867
harrison@maine.edu

On Fri, Oct 2, 2015 at 6:20 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Greetings lynx experts and other presenters!
>
> I've attached the draft agenda for the Oct. 13-15 lynx expert elicitation workshop in Minneapolis. It may be revised slightly as the timing of one or two presentations is still being discussed, but it should give you a feel for what to expect at the workshop.
>
> As you will see, except where there may be several presenters on a given topic or where one presenter will cover several topics or populations, we have assigned half-hour slots to most presentations. This is to include 20 minutes for presentations and 10 minutes for questions and discussion.
>
> I've reached out to most presenters to discuss the topics we hope you will cover. For those presenting the status updates on the individual lynx populations in the DPS, we would like the focus to be on the current versus historic and likely future status and threats to lynx in each particular geographic area (as opposed to updates on specific recent research efforts that otherwise do not address those areas). In addition to presenters, we will welcome discussion/ input from others on the expert panel who are familiar with lynx populations in specific geographic areas.
>
> For all presenters, we ask that you include notes within your presentations, as the presentations themselves will become part of the administrative record as we move forward with completing the SSA report and beginning the recovery planning process. Several of our State, Federal and Tribal partners have also asked that the presentations and other workshop materials be made available, and we hope to honor those requests. After the workshop, we will summarize the notes and proceedings, and we will distribute those to presenters and experts for your review before we distribute them to other interested parties.
>
> I've also attached (1) a one-pager with definitions of the "3 Rs" - Representation, Resiliency and Redundancy - which we consider when evaluating a species' likely viability; (2) a species status assessment (SSA) fact sheet that you may have seen before; and (3) a white paper describing the expert elicitation process and the need and methods to avoid conflicts with the Federal Advisory Committee Act (FACA) and the Administrative Procedures Act (APA).

Please review each of these documents before the workshop.

Next week, I will also send out some examples of the kinds of questions we will be trying address at the workshop, and some draft conceptual models we've worked up to try to illustrate factors/pathways that may influence lynx in the DPS in terms of the 3 Rs.

I'm really looking forward to seeing everyone in a few weeks and learning from your combined experience and expertise. Thanks again for agreeing to help us with the lynx SSA.

Have a great weekend!

Jim

--
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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
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(406) 449-5225 ext. 220
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--
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Montana Ecological Services Office
585 Shepard Way, Suite 1
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(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Google Calendar
To:	megan_kosterman@fws.gov; michael_carrier@fws.gov; lisa_solbergschwab@fws.gov; seth_willey@fws.gov; michelle_eames@fws.gov; tom_chapman@fws.gov; eric_rickerson@fws.gov; martin_miller@fws.gov; rollie_white@fws.gov; ann_belleman@fws.gov; jodi_bush@fws.gov; sue_livingston@fws.gov; anthony_tur@fws.gov; karl_halupka@fws.gov; leslie_ellwood@fws.gov; scott_hicks@fws.gov; bryon_holt@fws.gov; jim_zelenak@fws.gov; david_stilwell@fws.gov; peter_fasbender@fws.gov; kate_novak@fws.gov; larry_crist@fws.gov; steve_duke@fws.gov; laury_zicari@fws.gov; mark_sattelberg@fws.gov; paul_casey@fws.gov; sarah_hall@fws.gov; drue_deberry@fws.gov; eric_hein@fws.gov; kurt_broderdorp@fws.gov; tamara_smith@fws.gov; chris_mensing@fws.gov; mark_mccollough@fws.gov; kim_garner@fws.gov; wally_murphy@fws.gov; jeff_krupka@fws.gov; grant_canterbury@fws.gov; mark_maghini@fws.gov; paul_henson@fws.gov; mary_parkin@fws.gov
Cc:	scott_hicks@fws.gov; david_stilwell@fws.gov; paul_henson@fws.gov; kate_novak@fws.gov; megan_kosterman@fws.gov; seth_willey@fws.gov; steve_duke@fws.gov; larry_crist@fws.gov; bryon_holt@fws.gov; anthony_tur@fws.gov; jim_zelenak@fws.gov; tom_chapman@fws.gov; wally_murphy@fws.gov; michael_carrier@fws.gov; chris_mensing@fws.gov; rollie_white@fws.gov; mark_maghini@fws.gov; sarah_hall@fws.gov; jodi_bush@fws.gov; laury_zicari@fws.gov; eric_rickerson@fws.gov; grant_canterbury@fws.gov; ann_belleman@fws.gov; leslie_ellwood@fws.gov; martin_miller@fws.gov; kim_garner@fws.gov; paul_casey@fws.gov; sue_livingston@fws.gov; mark_sattelberg@fws.gov; peter_fasbender@fws.gov; drue_deberry@fws.gov; michelle_eames@fws.gov; eric_hein@fws.gov; kurt_broderdorp@fws.gov; lisa_solbergschwab@fws.gov; mark_mccollough@fws.gov; karl_halupka@fws.gov; tamara_smith@fws.gov; jeff_krupka@fws.gov
Subject:	[Update] Reminder - Monthly FWS Lynx SSA Coordination Call - 10-11 MDT
Date:	Tuesday, October 06, 2015 10:37:40 AM

Hi all,

Just a reminder that the monthly lynx SSA call is scheduled for today. Please check your calendars for the call-in information.

Thanks!

Reminder - Monthly FWS Lynx SSA Coordination Call - 10-11 MDT

Monthly internal update of progress on Canada lynx SSA

When Tue Oct 6, 2015 12pm – 1pm Eastern Time

Where (b) (5) CIP Passcode: (b) (5) (map)

Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin

Who
- mary_parkin@fws.gov - organizer
- jeffrey_dillon@fws.gov
- scott_hicks@fws.gov
- tyler_abbott@fws.gov
- david_stilwell@fws.gov
- paul_henson@fws.gov
- kate_novak@fws.gov
- megan_kosterman@fws.gov
- seth_willey@fws.gov
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- jim_zelenak@fws.gov
- wally_murphy@fws.gov
- tom_chapman@fws.gov

- michael_carrier@fws.gov
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- grant_canterbury@fws.gov
- leslie_ellwood@fws.gov
- laura_ragan@fws.gov
- martin_miller@fws.gov
- kim_garner@fws.gov
- paul_casey@fws.gov
- sue_livingston@fws.gov
- mark_sattelberg@fws.gov
- drue_deberry@fws.gov
- peter_fasbender@fws.gov
- michelle_eames@fws.gov
- eric_hein@fws.gov
- kurt_broderdorp@fws.gov
- lisa_solbergschwab@fws.gov
- karl_halupka@fws.gov
- mark_mccollough@fws.gov
- brady_mcgee@fws.gov
- tamara_smith@fws.gov
- jeff_krupka@fws.gov

From: Zicari, Laury
To: Mark McCollough
Subject: Fwd: Coordination call for lynx today
Date: Tuesday, October 06, 2015 11:24:38 AM

---

f y i
---------- Forwarded message ----------
From: **Miller, Martin** <martin_miller@fws.gov>
Date: Tue, Oct 6, 2015 at 10:59 AM
Subject: Re: Coordination call for lynx today
To: "Parkin, Mary" <mary_parkin@fws.gov>
Cc: Laury Zicari <Laury_Zicari@fws.gov>, Spencer Simon <Spencer_Simon@fws.gov>

I'll plan on calling in.

On Tue, Oct 6, 2015 at 10:26 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Hi all,
>
> The monthly internal coordination call for the lynx SSA is today at noon ET. Jim mentioned that he'd bring up the Maine experts situation briefly, then we could stay on the line after the call to sort it out more.
>
> The agenda has already gone out to the experts, but Jim agreed that we could reinstate Dan Harrison's full presentation time. He did say, however, that he'd need to give Jen Vashon an equal opportunity and suggested that she present first, on the distribution of lynx in the Northeast, followed by Dan.
>
> If you can call in, the info is:
>
> (b) (5) CIP Passcode: (b) (5) CIP
>
> Thanks,
> Mary
>
> --
> *Mary Parkin*
> *Endangered Species Recovery Coordinator, Northeast Region*
> *U.S. Fish and Wildlife Service, Hadley, MA*
> *Remotely located in Escalante, Utah:*
> *Mailing address PO Box 637, Escalante, UT 84726*
> *Street address 145 North Center St, Escalante, UT 84726*
> *Phone 617-417-3331*
> *Email mary_parkin@fws.gov*

--
Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

--

Laury Zicari
Field Supervisor
Maine Field Office
17 Godfrey Drive, Suite 2
Orono, ME 04473
207-866-3344 x 1111
Fax 866-3351
Cell 207-949-0561

From: Zicari, Laury
To: Miller, Martin; Mark McCollough
Cc: Parkin, Mary; Spencer Simon
Subject: Re: Coordination call for lynx today
Date: Tuesday, October 06, 2015 11:50:01 AM

I see that you are planning to stay on the line a bit after the regular conference call but I need to run off for a late lunch to pick up a new pair of lenses across town and need to split right at one. I have an appointment.

I would appreciate a note afterwards if that is not too much trouble so I know the lay of the land. Mark will be on the call and if you prefer I can just check in with him. thanks.

On Tue, Oct 6, 2015 at 10:59 AM, Miller, Martin <martin_miller@fws.gov> wrote:

> I'll plan on calling in.
>
> On Tue, Oct 6, 2015 at 10:26 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:
>
> > Hi all,
> >
> > The monthly internal coordination call for the lynx SSA is today at noon ET. Jim mentioned that he'd bring up the Maine experts situation briefly, then we could stay on the line after the call to sort it out more.
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> >
> > If you can call in, the info is:
> >
> > (b) (5) CIP Passcode: (b) (5) CIP
> >
> > Thanks,
> > Mary
> >
> > --
> > *Mary Parkin*
> > *Endangered Species Recovery Coordinator, Northeast Region*
> > *U.S. Fish and Wildlife Service, Hadley, MA*
> > *Remotely located in Escalante, Utah:*
> > *Mailing address PO Box 637, Escalante, UT 84726*
> > *Street address 145 North Center St, Escalante, UT 84726*
> > *Phone 617-417-3331*
> > *Email mary_parkin@fws.gov*

> --
> Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

--

Laury Zicari
Field Supervisor
Maine Field Office
17 Godfrey Drive, Suite 2
Orono, ME 04473
207-866-3344 x 1111
Fax 866-3351
Cell 207-949-0561

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: Core Team Call Today?
Date: Tuesday, October 20, 2015 11:24:27 AM

I can be on the call in a half hour... Mark

On Tue, Oct 20, 2015 at 11:23 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> I could go either way on our normally-scheduled call from 10-11 Mountain Time. If you feel strongly one way or the other (have the call or don't), let me know.
>
> If I don't hear back, I'll plan on dialing in and see if anyone joins.
>
> (b) (5) CIP
> passcode: (b) (5)
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Mark McCollough, Ph.D.
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Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Zelenak, Jim
To: Willey, Seth
Subject: Re: Reminder: Lynx SSA Coordination Call
Date: Thursday, October 22, 2015 3:43:33 PM

Your priorities are clearly in the right place! Plus....way more fun.

On Thu, Oct 22, 2015 at 3:41 PM, Willey, Seth <seth_willey@fws.gov> wrote:

> Unfortunately, I won't be able to make this one. Volunteering at my son's school.
>
> Sorry,
> Seth
>
> **********
> Seth L. Willey
> Acting Regional ESA Chief
> Mountain-Prairie Region, USFWS
> Seth_Willey@fws.gov
> 303-236-4257
> **********
>
> On Thu, Oct 22, 2015 at 3:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi All:
> >
> > Just a reminder that next Wednesday, Oct. 28, from 1 - 2:30 PM Mountain Time, we will hold our 4th monthly coordination call with State agencies regarding the species status assessment for the Canada lynx DPS.
> >
> > We will provide and update on the Expert Elicitation Workshop held last week in Minneapolis.
> >
> > Call-in: (b) (5) CIP
> > Participant passcode: (b) (5)
> >
> > If we have failed to include anyone from your agency on this distribution list, please forward this to them.
> >
> > --
> > Jim Zelenak, Biologist
> > U.S. Fish and Wildlife Service
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225 ext. 220
> > jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220

jim_zelenak@fws.gov

From:	Google Calendar
To:	kurt_broderdorp@fws.gov; jwcummings@usgs.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; bryon_holt@fws.gov; heather_bell@fws.gov; mary_parkin@fws.gov; jim_zelenak@fws.gov
Cc:	kurt_broderdorp@fws.gov; heather_bell@fws.gov; mary_parkin@fws.gov; bryon_holt@fws.gov; jwcummings@usgs.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov
Subject:	[Update] Lynx SSA Core Team call
Date:	Tuesday, October 27, 2015 10:15:30 AM

Hi All:

Core Team call at 10 AM Mountain Time this morning.

(b) (5) CIP
pass:(b) (5) CIP

Talk to you then.

Lynx SSA Core Team call

When Tue Oct 27, 2015 10am – 11am Mountain Time

Video call https://plus.google.com/hangouts/_/doi.gov/jim-zelenak

Who
- jim_zelenak@fws.gov - organizer

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Kurt Broderdorp; Bryon Holt; Jonathan Cummings; Seth Willey; Jodi Bush
Cc: Heather Bell; Mary Parkin; Susan Oetker
Subject: Fwd: Lynx SSA
Date: Monday, November 09, 2015 1:53:33 PM

Hi Core Team et al.,

Below is the webinar link we will use for the Lynx SSA call tomorrow (starting at 9 AM Mountain Time), where Susan Oetker will start us off with a presentation on her recent SSA work.

Same call-in number & pass code as usual:

(b) (5) CIP
Participant passcode: (b) (5)

Talk to you then!

Jim

---------- Forwarded message ----------
From: **Oetker, Susan** <susan_oetker@fws.gov>
Date: Wed, Nov 4, 2015 at 9:58 AM
Subject: Re: Lynx SSA
To: "Zelenak, Jim" <jim_zelenak@fws.gov>
Cc: Heather Bell <heather_bell@fws.gov>, Mary Parkin <mary_parkin@fws.gov>

Hi Jim- I do have a webinar link. Here you go.

(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP

I'm only able to be on the call until noon eastern- I hope that's okay. My presentation should only go 20 min or so, plus questions.

Susan

Susan Rogers Oetker
US Fish and Wildlife Service
Region 2- RO Ecological Services
1875 Century Blvd NE, Suite 200
Atlanta, GA 30345
404-679-7050
cell-505-856-8573
fax 404-679-7081

On Wed, Nov 4, 2015 at 11:44 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Susan,
>
> Glad you'll be able to join us next Tues. Do you have a webinar account/link to use for sharing your springtail SSA work? Or would you like me to use our office My Meetings acct. for the webinar and then hand the controls

> over to you?
>
> Let me know.
>
> Thanks,
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Mary Parkin
Cc:	Bryon Holt; Kurt Broderdorp; Jonathan Cummings; Heather Bell; Tamara Smith; Mark McCollough; Jodi Bush; Seth Willey
Subject:	Re: Updated Invitation: Lynx SSA Core Team Call - 9:30-11 MST @ Tue Nov 24, 2015 9:30am - 11am (jim_zelenak@fws.gov)
Date:	Tuesday, November 24, 2015 10:07:36 AM

Call-in: (b) (5) CIP
Participant passcode: (b) (5)

On Tue, Nov 24, 2015 at 7:57 AM, Mary Parkin <mary_parkin@fws.gov> wrote:

> **This event has been changed.**
>
> **Changed: Lynx SSA Core Team Call - 9:30-11 MST** **more details »**
>
> When Tue Nov 24, 2015 9:30am – 11am Mountain Time
>
> Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin
>
> Calendar jim_zelenak@fws.gov
>
> Who
> - mary_parkin@fws.gov - organizer
> - bryon_holt@fws.gov
> - kurt_broderdorp@fws.gov
> - jwcummings@usgs.gov
> - jim_zelenak@fws.gov
> - heather_bell@fws.gov
> - tamara_smith@fws.gov
> - mark_mccollough@fws.gov
> - jodi_bush@fws.gov - optional
> - seth_willey@fws.gov - optional
>
> Going? **Yes** - **Maybe** - **No** more options »
>
> Invitation from Google Calendar
>
> You are receiving this email at the account jim_zelenak@fws.gov because you are subscribed for updated invitations on calendar jim_zelenak@fws.gov.
>
> To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.
>
> Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Google Calendar
To: kurt_broderdorp@fws.gov; jodi_bush@fws.gov; jwcummings@usgs.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; seth_willey@fws.gov; bryon_holt@fws.gov; jim_zelenak@fws.gov; heather_bell@fws.gov; mary_parkin@fws.gov
Cc: seth_willey@fws.gov; kurt_broderdorp@fws.gov; heather_bell@fws.gov; jodi_bush@fws.gov; bryon_holt@fws.gov; jwcummings@usgs.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov; jim_zelenak@fws.gov
Subject: [Update] Lynx SSA Core Team Call - 9:30-11 MST
Date: Tuesday, January 05, 2016 8:46:14 AM

A reminder: core team call in ~ 45 minutes!

Lynx SSA Core Team Call - 9:30-11 MST

When Tue Jan 12, 2016 11:30am – 1pm Eastern Time

Where (b) (5) CIP(b) (5) CIP (map)

Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin

Who
- mary_parkin@fws.gov - organizer
- kurt_broderdorp@fws.gov
- heather_bell@fws.gov
- bryon_holt@fws.gov
- jwcummings@usgs.gov
- mark_mccollough@fws.gov
- tamara_smith@fws.gov
- jim_zelenak@fws.gov
- seth_willey@fws.gov - optional
- jodi_bush@fws.gov - optional

From:	Parkin, Mary
To:	Kurt Broderdorp; Jodi Bush; Jonathan Cummings; Tamara Smith; Mark McCollough; Seth Willey; Bryon Holt; Jim Zelenak; Heather Bell; Mary Parkin
Subject:	Re: [Update] Lynx SSA Core Team Call - 9:30-11 MST
Date:	Tuesday, January 05, 2016 8:56:42 AM

Please disregard -- I was looking at next week's calendar! The core team call for today will begin in 5 minutes. Apologies,
Mary

On Tue, Jan 5, 2016 at 10:46 AM, <mary_parkin@fws.gov> wrote:

> A reminder: core team call in ~ 45 minutes!
>
> **Lynx SSA Core Team Call - 9:30-11 MST**
>
> When Tue Jan 12, 2016 11:30am – 1pm Eastern Time
>
> Where (b) (5) CIP(b) (5) CIP (map)
>
> Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin
>
> Who
> - mary_parkin@fws.gov - organizer
> - kurt_broderdorp@fws.gov
> - heather_bell@fws.gov
> - bryon_holt@fws.gov
> - jwcummings@usgs.gov
> - mark_mccollough@fws.gov
> - tamara_smith@fws.gov
> - jim_zelenak@fws.gov
> - seth_willey@fws.gov - optional
> - jodi_bush@fws.gov - optional

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From:	Google Calendar
To:	kurt_broderdorp@fws.gov; jodi_bush@fws.gov; jwcummings@usgs.gov; tamara_smith@fws.gov; mark_mccollough@fws.gov; seth_willey@fws.gov; bryon_holt@fws.gov; heather_bell@fws.gov; mary_parkin@fws.gov; jim_zelenak@fws.gov
Cc:	seth_willey@fws.gov; kurt_broderdorp@fws.gov; heather_bell@fws.gov; jodi_bush@fws.gov; mary_parkin@fws.gov; bryon_holt@fws.gov; jwcummings@usgs.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov
Subject:	[Reminder] Lynx SSA Core Team Call - 9-10 MST
Date:	Monday, February 29, 2016 5:34:02 PM

Reminder to Lynx SSA COre Team that we will have a call from 9 - 10 Am Mountain Time tomorrow, Tues., Mar. 1. The intra-FWS call with the larger Service group will follow at 10 AM MST.

Lynx SSA Core Team Call - 9-10 MST

This call will immediately precede the internal FWS coordination call.

When Tue Mar 1, 2016 9am – 10am Mountain Time

Where (b) (5) CIP(b) (5) CIP (map)

Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin

Who
- mary_parkin@fws.gov - organizer
- mark_mccollough@fws.gov
- kurt_broderdorp@fws.gov
- jwcummings@usgs.gov
- tamara_smith@fws.gov
- bryon_holt@fws.gov
- jim_zelenak@fws.gov
- heather_bell@fws.gov
- jodi_bush@fws.gov - optional
- seth_willey@fws.gov - optional

From: Google Calendar

To: megan_kosterman@fws.gov; lisa_solbergschwab@fws.gov; patricia_zenone@fws.gov; seth_willey@fws.gov; michelle_eames@fws.gov; tom_chapman@fws.gov; eric_rickerson@fws.gov; martin_miller@fws.gov; ann_belleman@fws.gov; lisa_mandell@fws.gov; rollie_white@fws.gov; jodi_bush@fws.gov; tyler_abbott@fws.gov; sue_livingston@fws.gov; anthony_tur@fws.gov; ann_timberman@fws.gov; karl_halupka@fws.gov; leslie_ellwood@fws.gov; scott_hicks@fws.gov; brad_thompson@fws.gov; bryon_holt@fws.gov; jim_zelenak@fws.gov; david_stilwell@fws.gov; peter_fasbender@fws.gov; kate_novak@fws.gov; scott_grunder@fws.gov; larry_crist@fws.gov; steve_duke@fws.gov; dennis_mackey@fws.gov; laura_ragan@fws.gov; mark_sattelberg@fws.gov; brady_mcgee@fws.gov; paul_casey@fws.gov; sarah_hall@fws.gov; drue_deberry@fws.gov; kurt_broderdorp@fws.gov; tamara_smith@fws.gov; chris_mensing@fws.gov; mark_mccollough@fws.gov; kim_garner@fws.gov; jeffrey_dillon@fws.gov; jeff_krupka@fws.gov; wally_murphy@fws.gov; grant_canterbury@fws.gov; mark_maghini@fws.gov; paul_henson@fws.gov; mary_parkin@fws.gov

Cc: jeffrey_dillon@fws.gov; scott_hicks@fws.gov; tyler_abbott@fws.gov; david_stilwell@fws.gov; paul_henson@fws.gov; kate_novak@fws.gov; megan_kosterman@fws.gov; seth_willey@fws.gov; steve_duke@fws.gov; larry_crist@fws.gov; bryon_holt@fws.gov; anthony_tur@fws.gov; jim_zelenak@fws.gov; scott_grunder@fws.gov; tom_chapman@fws.gov; wally_murphy@fws.gov; ann_timberman@fws.gov; chris_mensing@fws.gov; rollie_white@fws.gov; lisa_mandell@fws.gov; mark_maghini@fws.gov; sarah_hall@fws.gov; eric_rickerson@fws.gov; jodi_bush@fws.gov; ann_belleman@fws.gov; grant_canterbury@fws.gov; leslie_ellwood@fws.gov; laura_ragan@fws.gov; martin_miller@fws.gov; kim_garner@fws.gov; paul_casey@fws.gov; sue_livingston@fws.gov; mark_sattelberg@fws.gov; drue_deberry@fws.gov; peter_fasbender@fws.gov; michelle_eames@fws.gov; dennis_mackey@fws.gov; kurt_broderdorp@fws.gov; brad_thompson@fws.gov; lisa_solbergschwab@fws.gov; brady_mcgee@fws.gov; karl_halupka@fws.gov; mark_mccollough@fws.gov; tamara_smith@fws.gov; jeff_krupka@fws.gov; patricia_zenone@fws.gov

Subject: [Update] FWS Lynx SSA Coordination Call - 10-11 MDT

Date: Monday, February 29, 2016 5:39:07 PM

Hi all,
This FWS coordination call for the lynx SSA is still scheduled for 9 am PST, 10 MST, 11 CST, and 12 EST tomorrow (and happy March!). It will be brief, but we do have some significant updates to share. We hope you can join us.
Thanks,
Lynx SSA team

FWS Lynx SSA Coordination Call - 10-11 MDT

Update on lynx expert elicitation workshop and next steps

When Tue Mar 1, 2016 12pm – 1pm Eastern Time

Where (b) (5) CIP Passcode: (b) (5) (map)

Video call https://plus.google.com/hangouts/_/doi.gov/mary-parkin

Who
- mary_parkin@fws.gov - organizer
- michelle_eames@fws.gov
- martin_miller@fws.gov
- jodi_bush@fws.gov
- lisa_mandell@fws.gov
- laura_ragan@fws.gov
- patricia_zenone@fws.gov
- jeffrey_dillon@fws.gov
- david_stilwell@fws.gov
- kate_novak@fws.gov
- tyler_abbott@fws.gov
- mark_maghini@fws.gov
- kurt_broderdorp@fws.gov
- ann_timberman@fws.gov

- peter_fasbender@fws.gov
- scott_hicks@fws.gov
- drue_deberry@fws.gov
- karl_halupka@fws.gov
- grant_canterbury@fws.gov
- sarah_hall@fws.gov
- wally_murphy@fws.gov
- dennis_mackey@fws.gov
- anthony_tur@fws.gov
- paul_casey@fws.gov
- mark_mccollough@fws.gov
- steve_duke@fws.gov
- chris_mensing@fws.gov
- larry_crist@fws.gov
- sue_livingston@fws.gov
- megan_kosterman@fws.gov
- rollie_white@fws.gov
- paul_henson@fws.gov
- leslie_ellwood@fws.gov
- seth_willey@fws.gov
- brady_mcgee@fws.gov
- jim_zelenak@fws.gov
- tom_chapman@fws.gov
- eric_rickerson@fws.gov
- jeff_krupka@fws.gov
- bryon_holt@fws.gov
- mark_sattelberg@fws.gov
- brad_thompson@fws.gov
- ann_belleman@fws.gov
- scott_grunder@fws.gov
- kim_garner@fws.gov
- lisa_solbergschwab@fws.gov
- tamara_smith@fws.gov

From: Smith_Tamara
To: Peter Fasbender; Lisa Mandell
Subject: Fwd: March 11, 2016 10:30 am MTN Briefing and webinar info
Date: Friday, March 11, 2016 9:00:10 AM
Attachments: 20160311_Briefing Lynx SSA Status Update.docx

Hi Pete and Lisa -
Forwarding this...in case this has not been sent to you yet. I'll plan to sit in on the briefing today. -Tam

---------- Forwarded message ----------
From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Thu, Mar 10, 2016 at 5:16 PM
Subject: March 11, 2016 10:30 am MTN Briefing and webinar info
To: Lynn Lewis <lynn_lewis@fws.gov>, Michael Thabault <michael_thabault@fws.gov>, Paul Henson <paul_henson@fws.gov>, Paul Phifer <paul_phifer@fws.gov>
Cc: Bryon Holt <bryon_holt@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Marjorie Nelson <marjorie_nelson@fws.gov>, Heather Bell <heather_bell@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Karen St Cyr <karen_stcyr@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>

Hey folks. Here is a briefing document and webinar information for tomorrows call/webinar, which is at 10:30 AM MTN time.
If you have any problems please call me here at main number at 406.449.5225, ext. 0.
My receptionist can track me down if folks are having issues. Thanks for tuning in. thanks. JB

The call in information remains (b) (5) Commerical Information

---

You are invited to join a meeting hosted by BRENT ESMOIL (Jodi Bush). Meeting details are listed below. Meeting Date: 03/11/2016 Meeting Time: 10:30 PM MOUNTAIN TIME Instant Net Conference Details: ---------- Meeting Number: (b) (5) Commerical Meeting Passcode: Meeting Host: BRENT ESMOIL (Jodi Bush) Join Instructions for Instant Net Conference: 1. Join the meeting now: (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP . Enter the required fields. 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext 219 NEW NUMBER
952-646-2873 NEW FAX

612-600-1599 Cell

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: Core Team Call
Date: Tuesday, March 15, 2016 10:00:55 AM

Thanks Jim...Mark

On Tue, Mar 15, 2016 at 9:59 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> We have a Core Team Call scheduled for this morning at 09:30 Mountain Time. I think it would be good to touch base on a few things, but I hope we can have a very short call so I can wrap up the final changes/additions to the Workshop Report based on the last of the comments/edits submitted by experts late last week, and then get the formatting done so I can get the report to Jodi so she can share with ARDs/ROs.
>
> Let me know if you have any topics of concern.
>
> I anticipate some discussion with the group regarding the discussions Mark and I have had on Jen Vashon's comments on the workshop report - the approach we've sort of settle on. I'd also like to hear from Kurt regarding mapping of the W. Colorado unit for SSA ownership and other analyses. Also anything Mary, Heather or Jonathan feel we need to discuss.
>
> Usual call in info:
>
> (b) (5) CIP
> passcode: (b) (5) CIP
>
> Thanks.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Parkin, Mary
To: Zelenak, Jim
Subject: Re: [Reminder] FWS Lynx SSA Coordination Call - 10-11 MDT, Tues. April 5
Date: Monday, April 04, 2016 4:10:38 PM

Thank you, Jim! I won't be free to attend but hope the rest of the FIT cadre will.
Cheers,
Mary

On Mon, Apr 4, 2016 at 4:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All,
>
> The monthly FWS coordination call for the lynx SSA is scheduled for 9 am PST, 10 MST, 11 CST, and 12 EST tomorrow. We will also have a brief webinar (info below). We hope you can join us.
>
> Thanks,
>
> Lynx SSA team
>
> Call-in info:
>
> (b) (5) CIP
> Passcode: (b) (5) CIP
>
> Webinar info:
>
> You are invited to join a meeting hosted by Jim Zelenak. Meeting details are listed below.
>
> Meeting Date: 04/05/2016
> Meeting Time: 10:00 AM MOUNTAIN TIME
>
> Instant Net Conference Details:
> ---
> Meeting Number: 446939152
> Meeting Passcode:
> Meeting Host: BRENT ESMOIL
>
> Join Instructions for Instant Net Conference:
>
> 1. Join the meeting now:
> (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
> 2. Enter the required fields.
> 3. Indicate that you have read the Privacy Policy.
> 4. Click on Proceed.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office

585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--

Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Zelenak, Jim
To: Seth Willey; Jodi Bush; Mary Parkin; Heather Bell; Kurt Broderdorp; Ann Timberman; Leslie Ellwood; Drue DeBerry; Lisa Solberg Schwab; Mark Sattelberg; Tyler Abbott; Larry Crist; Kate Novak; Sarah Hall; Paul Henson; Bryon Holt; Megan Kosterman; Kim Garner; Eric Rickerson; Jeff Krupka; Brad Thompson; Michelle Eames; Karl Halupka; Sue Livingston; Rollie White; Dennis Mackey; Jeffrey Dillon; Grant Canterbury; Gary Miller; Wally Murphy; Patricia Zenone; Brady McGee; Scott Hicks; Chris Mensing; Peter Fasbender; Lisa Mandell; Tamara Smith; Ann Belleman; Jessica Hogrefe; Laura Ragan; Mark McCollough; Kevin Foster; Paul Casey; Martin Miller; Anthony Tur; Tom Chapman; Mark Maghini; David Stilwell
Subject: [Reminder] FWS Lynx SSA Coordination Call - 10-11 MDT, Tues. April 5
Date: Monday, April 04, 2016 4:40:58 PM

Hi All,

The monthly FWS coordination call for the lynx SSA is scheduled for 9 am PST, 10 MST, 11 CST, and 12 EST tomorrow. We will also have a brief webinar (info below). We hope you can join us.

Thanks,

Lynx SSA team

Call-in info:

(b) (5) CIP
Passcode: (b) (5) CIP

Webinar info:

You are invited to join a meeting hosted by Jim Zelenak. Meeting details are listed below.

Meeting Date: 04/05/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: 446939152
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1

Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Belleman, Ann
To: Zelenak, Jim
Subject: Re: [Reminder] FWS Lynx SSA Coordination Call - 10-11 MDT, Tues. April 5
Date: Monday, April 04, 2016 4:45:51 PM

Hi Jim,

Hope you're well! You can remove my name from this email list, as I'm no longer participating in these sessions.

Thanks - Ann

Ann Belleman
U.S. Fish and Wildlife Service
Twin Cities Field Office (TCFO)
4101 American Blvd. E
Bloomington, MN 55425-1665

ann_belleman@fws.gov

612-600-6122 (work cell) - *This is my primary number!*
952-252-0092 (TCFO) - *Note: I work remotely, so am not located at TCFO. If you don't reach me on my work cell and need immediate assistance, then please call this TCFO main number.*

On Mon, Apr 4, 2016 at 3:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All,
>
> The monthly FWS coordination call for the lynx SSA is scheduled for 9 am PST, 10 MST, 11 CST, and 12 EST tomorrow. We will also have a brief webinar (info below). We hope you can join us.
>
> Thanks,
>
> Lynx SSA team
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> ---
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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: [Reminder] FWS Lynx SSA Coordination Call - 10-11 MDT, Tues. April 5
Date: Monday, April 04, 2016 5:58:34 PM
Attachments: 20160329 Ch 4 Climate change.docx

Jim: I will try to participate, but will be at a workshop and may not be able to get away.

I wrote a draft introduction to climate change and ME climate section (attached). Both need more work, but want to share what I have been working on to avoid duplication. You're welcome to post on google.docs to make it easier for everyone to edit.

Mark

On Mon, Apr 4, 2016 at 4:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

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>
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--
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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Zelenak, Jim
To: McCollough, Mark
Subject: Re: [Reminder] FWS Lynx SSA Coordination Call - 10-11 MDT, Tues. April 5
Date: Tuesday, April 05, 2016 12:56:28 PM

Thanks again for diving right in Mark. I will take a look and either get back to you or post on the drive and let the others know.

On Mon, Apr 4, 2016 at 3:58 PM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Jim: I will try to participate, but will be at a workshop and may not be able to get away.
>
> I wrote a draft introduction to climate change and ME climate section (attached). Both need more work, but want to share what I have been working on to avoid duplication. You're welcome to post on google.docs to make it easier for everyone to edit.
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>
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> >
> > Lynx SSA team
> >
> > Call-in info:
> >
> > [redacted]
> > Passcode: [redacted]
> >
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> >
> > 1. Join the meeting now:
> > http://www.mymeetings.com/nc/join.php?sigKey=mymeetings&i=446939152&p=&t=c
> > 2. Enter the required fields.

> 3. Indicate that you have read the Privacy Policy.
> 4. Click on Proceed.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
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jim_zelenak@fws.gov

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>
> --
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> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

> --
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585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Jodi Bush
Subject: Fwd: Invitation for Instant Net Conference
Date: Friday, April 08, 2016 9:39:48 AM

Below is the webinar link/info for the RD lynx briefing on Monday 4/11. No passcode needed for the webinar. I can change host name to yours if you prefer.

Conference line call-in number (b) (5) CIP
Participant passcode: (b) (5)

RO - Mike, Marjorie, Seth, and Craig Hansen
SSA Team - Heather B., Mary Parkin, Jonathan Cummings, Mark McCullough, Tamara Smith, Bryon Holt, Kurt Broderdorp

If you just want to send it to RO and CC me, I can forward to SSA Team.

Thanks.

---------- Forwarded message ----------
From: <e-meetings@mymeetings.com>
Date: Thu, Apr 7, 2016 at 3:43 PM
Subject: Invitation for Instant Net Conference
To: JIM_ZELENAK@fws.gov

You are invited to join a meeting hosted by Jim Zelenak. Meeting details are listed below.

Meeting Date: 04/11/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: 446939152
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service

Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Hansen, Craig
Subject: Re: Invitation for Instant Net Conference
Date: Friday, April 08, 2016 12:44:33 PM

---

thanks Craig.

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Fri, Apr 8, 2016 at 12:34 PM, Hansen, Craig <craig_hansen@fws.gov> wrote:

> Copy. I'll have this set up for you in the RD's conference room.
>
> Craig.
>
> Craig Hansen
> Fish and Wildlife Biologist
> Mountain-Prairie Regional Office
> Endangered Species Program
> (303) 236-4749
> --
>
> 
>
> *The mission of the U.S. Fish and Wildlife Service is to work with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.*
> **********
> NOTE: All email correspondence and attachments received from or sent to me are subject to the Freedom of Information Act (FOIA) and may be disclosed to third parties.
> **********
>
> On Fri, Apr 8, 2016 at 12:31 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
>
> > Below is the webinar link/info for the RD lynx briefing on Monday 4/11. No passcode needed for the webinar. The briefing and ppt were sent to RO staff on April 7.
> >
> > Conference line call-in number: (b) (5) CIP
> > Participant passcode: (b) (5)

Thanks.

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
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---------- Forwarded message ----------
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Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Kurt Broderdorp
To: Jim Zelenak
Subject: RE: Core Team Call
Date: Tuesday, April 12, 2016 10:52:03 AM

I had another commitment, did I miss anything?

Kurt Broderdorp
US Fish and Wildlife Service
(970) 628-7186

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, April 12, 2016 8:46 AM
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Core Team Call

Hi Team:

Sorry we don't have this on calendars, but if possible I'd like to have a quick Core Team call today at our usual time - 10 AM Mountain time.

(b) (5) CIP
passcode: (b) (5) CIP

Hope you can join.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Jim Zelenak
Subject: Fwd: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 10:55:59 AM

---

found this...JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Mon, Jul 20, 2015 at 3:39 PM
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
To: "Bush, Jodi" <jodi_bush@fws.gov>

We are still needing signatures on the project plan from:

WYFO (Mark Sattleberg)
WAFO (Eric Rickerson)
R2 ARD (Name?)
NEFO (Tom Chapman)
R6 ARD (Mike T - wants to sign last).

On Mon, Jul 20, 2015 at 3:03 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> I don't know where we are on these but....JB
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> ---------- Forwarded message ----------
> From: **Phifer, Paul** <paul_phifer@fws.gov>
> Date: Mon, Jul 20, 2015 at 2:52 PM
> Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
> To: "Bush, Jodi" <jodi_bush@fws.gov>
> Cc: Tom Chapman <tom_chapman@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, Laury Zicari <laury_zicari@fws.gov>, Martin Miller <Martin_Miller@fws.gov>, Mary Parkin <mary_parkin@fws.gov>

Jodi - sorry this took me a while to get back to you. I appreciate the good coordination.

Paul

Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.
>
> For ease of collating signatures please use any of the following methods to add your signature to the document.
>
> 1. Open the attached pdf document in Adobe Reader. Click on the fill and sign tab and make a selection for your signature of the document. **Save and send back to Jim Zelenak.**
>
> 2. Sign a hardopy of the signature page (10), **scan and send back to Jim Zelenak.**
>
> 3. Add your signature in the word document by adding /s/ Your Name. **Save and send back to Jim Zelenak.**
>
> You should have also received notice of what will be our monthly internal FWS coordination calls on the process from Jim Zelanak.
> We will be conducting these calls the first tuesday of every month at 10am Mtn time.
> Call in information is as follows: (b) (5) CIP , passcode: (b) (5) CIP
>
> Shortly I will also be sending out another letter for our state partners. As we know, the States are particularly interested in being engaged in our Lynx recovery planning process. To that end, the letter updates where we are now and identifies a monthly coordination call with our state partners to keep them appraised of our progress. It would be helpful if versions of this state letter were sent out from your offices. Please use the version I provide to you as a template.
>
> Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Jonathan Cummings
Subject: Fwd: lynx call?
Date: Monday, April 25, 2016 11:31:59 AM

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Mon, Apr 25, 2016 at 9:30 AM
Subject: Re: lynx call?
To: "Parkin, Mary" <mary_parkin@fws.gov>

Great - thanks.

As usual:

(b) (5) CIP
(b) (5)

Talk to you then.

On Mon, Apr 25, 2016 at 9:23 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Sounds good to me, especially since I've missed the last few.
>
> On Mon, Apr 25, 2016 at 11:12 AM, Bell, Heather <heather_bell@fws.gov> wrote:
>
> > I am available and happy to give a pep talk!
> >
> > Heather Bell
> > Ecological Services HQ
> > Division of Restoration and Recovery
> > SSA Framework Team Lead
> > Remotely Located at
> > 134 S. Union Blvd
> > Lakewood, CO 80228
> > 303-236-4514
> >
> > Check it out! SSA Framework - Google Site for Staff
> > at https://sites.google.com/a/fws.gov/ssa/ and the REV Google
> > Site: https://sites.google.com/a/fws.gov/rev/. For audiences outside FWS
> > visit http://www.fws.gov/endangered/improving_ESA/SSA.html.
> >
> > On Mon, Apr 25, 2016 at 9:09 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Hi All:
> > >
> > > We don't have it on our calendars, but are folks feeling like a call is needed? And, if so, are folks available at our normal Mon. time of 11-12 Mountain time?
> > >
> > > I don't have a lot to say but could maybe use a pep talk - not seeing/feeling the document coming together and Jodi is looking for a draft soon.

> > Also would like to talk to Core tomorrow and see if after today we/I can give some calrity on assignments/timeline.
> >
> > Let me know.
> >
> > Thanks
> >
> > --
> > Jim Zelenak, Biologist
> > U.S. Fish and Wildlife Service
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225 ext. 220
> > jim_zelenak@fws.gov
>
> --
> *Mary Parkin*
> *Endangered Species Recovery Coordinator, Northeast Region*
> *U.S. Fish and Wildlife Service, Hadley, MA*
> *Remotely located in Escalante, Utah:*
> *Mailing address PO Box 637, Escalante, UT 84726*
> *Street address 145 North Center St, Escalante, UT 84726*
> *Phone 617-417-3331*
> *Email mary_parkin@fws.gov*

--
Jim Zelenak, Biologist
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--
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(406) 449-5225 ext. 220

jim_zelenak@fws.gov

From: Bush, Jodi
To: Zelenak, Jim
Cc: McCollough, Mark; Tom Chapman
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 11:46:58 AM

---

thanks folks. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Apr 25, 2016 at 11:43 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Mark - we already have MEFO and R5 ARD signature.
>
> On Mon, Apr 25, 2016 at 11:40 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > I will have our acting PL, Steve Spangle, sign today. I'll try to get a signed copy back to you today. Mark
> >
> > On Mon, Apr 25, 2016 at 1:01 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > > Tom/Mark. We need a NEW ENGLAND Project Leader signature on the attached signature sheet for the Lynx Project Plan. We never recieved one. Your ARD has signed. JB
> > >
> > > Jodi L. Bush
> > > Field Supervisor
> > > Montana Ecological Services Office
> > > 585 Shepard Way, Suite 1
> > > Helena, MT 59601
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> > >
> > > On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> > >
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Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
Jim Zelenak, Biologist

U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Zelenak, Jim
Cc: McCollough, Mark; Tom Chapman
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 11:46:58 AM

---

thanks folks. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Apr 25, 2016 at 11:43 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Mark - we already have MEFO and R5 ARD signature.
>
> On Mon, Apr 25, 2016 at 11:40 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > I will have our acting PL, Steve Spangle, sign today. I'll try to get a signed copy back to you today. Mark
> >
> > On Mon, Apr 25, 2016 at 1:01 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > > Tom/Mark. We need a NEW ENGLAND Project Leader signature on the attached signature sheet for the Lynx Project Plan. We never recieved one. Your ARD has signed. JB
> > >
> > > Jodi L. Bush
> > > Field Supervisor
> > > Montana Ecological Services Office
> > > 585 Shepard Way, Suite 1
> > > Helena, MT 59601
> > > (406) 449-5225, ext.205
> > >
> > > On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> > >
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> > > >
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> > > > 1. Open the attached pdf document in Adobe Reader. Click on the fill and sign tab and make a selection for your signature of the document. **Save and send back to Jim Zelenak.**

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585 Shepard Way, Suite 1
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(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Abbott, Tyler
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 11:59:16 AM

---

yes. Thanks. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Apr 25, 2016 at 11:49 AM, Abbott, Tyler <tyler_abbott@fws.gov> wrote:

> Hi Jodi,
>
> Please see attached-- hopefully this works for you.
>
> Thanks, Tyler
>
> On Mon, Apr 25, 2016 at 11:04 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
>
> > Hey Tyler-
> >
> > We need a Wyoming Project Leader signature on the attached signature sheet for the Lynx Project Plan. We never received one. Thanks. JB
> >
> > Jodi L. Bush
> > Field Supervisor
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225, ext.205
> >
> > On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > > Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.
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> > > 1. Open the attached pdf document in Adobe Reader. Click on the fill and sign tab and make a selection for your signature of the document. **Save and send back to Jim Zelenak.**

2. Sign a hardopy of the signature page (10), **scan and send back to Jim Zelenak.**

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Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--

Tyler Abbott, Acting Field Supervisor

U.S. Fish and Wildlife Service
Wyoming Ecological Services Field Office
5353 Yellowstone Road, Suite 308A
Cheyenne, WY 82009
Office: (307) 772-2374 x 231
Cell: (307) 286-7242
tyler_abbott@fws.gov

From: Bush, Jodi
To: Chapman, Tom
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 12:00:11 PM

---

yes. thanks

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Mon, Apr 25, 2016 at 11:57 AM, Chapman, Tom <tom_chapman@fws.gov> wrote:

> Here's the page with my signature.
>
> Tom
>
> On Mon, Apr 25, 2016 at 1:52 PM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Tom: I misread this request a few minutes ago. We need your signature on this project plan. Please sign and return to Jodi. Thanks, Mark
> > ---------- Forwarded message ----------
> > From: **Bush, Jodi** <jodi_bush@fws.gov>
> > Date: Mon, Apr 25, 2016 at 1:01 PM
> > Subject: Fwd: SIGNATURE NEEDED: Final Lynx Project Plan
> > To: Tom Chapman <Tom_Chapman@fws.gov>
> > Cc: Mark McCollough <Mark_McCollough@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>
> >
> > Tom/Mark. We need a NEW ENGLAND Project Leader signature on the attached signature sheet for the Lynx Project Plan. We never recieved one. Your ARD has signed. JB
> >
> > Jodi L. Bush
> > Field Supervisor
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
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17 Godfrey Drive, Suite 2

Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--

Thomas R. Chapman
Supervisor - New England Field Office
U.S. Fish & Wildlife Service
Northeast Region - Ecological Services
70 Commercial St., Suite 300
Concord, NH 03301

603.223.2541 ext. 6410
603.724.5104 cell

From: McCollough, Mark
To: Chapman, Tom
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 1:58:50 PM

Thanks Tom! We haven't needed much of Tony's time for the lynx SSA. But there will be a time in the near future when we could use his review of sections pertaining to NH and VT. Thanks, Mark

On Mon, Apr 25, 2016 at 1:57 PM, Chapman, Tom <tom_chapman@fws.gov> wrote:

> Here's the page with my signature.
>
> Tom
>
> On Mon, Apr 25, 2016 at 1:52 PM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Tom: I misread this request a few minutes ago. We need your signature on this project plan. Please sign and return to Jodi. Thanks, Mark
> > ---------- Forwarded message ----------
> > From: **Bush, Jodi** <jodi_bush@fws.gov>
> > Date: Mon, Apr 25, 2016 at 1:01 PM
> > Subject: Fwd: SIGNATURE NEEDED: Final Lynx Project Plan
> > To: Tom Chapman <Tom_Chapman@fws.gov>
> > Cc: Mark McCollough <Mark_McCollough@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>
> >
> > Tom/Mark. We need a NEW ENGLAND Project Leader signature on the attached signature sheet for the Lynx Project Plan. We never recieved one. Your ARD has signed. JB
> >
> > Jodi L. Bush
> > Field Supervisor
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mark_mccollough@fws.gov

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Monday, April 25, 2016 2:47:32 PM

Its hard to start writing this SSA from scratch. Furthermore, its hard to know how much information to include in a "light" version. What do decision-maker's want or not want? The example SSAs are a bit helpful, but not the best examples for representing a species for which we have lots of information. My sense is that by taking more time to capture the more detailed information in this SSA, then we save time in the future by not having to repeat/rewrite it again. Or do the powers that be expect something simpler?

Mark

On Mon, Apr 25, 2016 at 2:39 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> I will soon send out a request to Core Team for a call tomorrow. Think it would be good for us all to touch base.
>
> Was on a call with Heather, Mary, Jonathan when you emailed earlier.
>
> Thanks for taking the initiative on the writing. I'm struggling to write some of my parts and to see this report coming together. But will keep plugging away.
>
> On Mon, Apr 25, 2016 at 11:48 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Sorry Jim. I misread New England to mean R5. I thought we had signed this...
> >
> > Do we have a Core Team call this week?
> >
> > I have been working on Chapter 5...stressors. Hope that is OK. I revised some of the climate change section after getting more info from Alexej and the Maine Climate Change Institute. Starting on vegetation management/forestry today. Plan to "borrow" a lot from the LCAS.
> >
> > Let me know if this is OK or whether you would like me to focus on some of the other things we discussed last week.
> >
> > Mark
> >
> > On Mon, Apr 25, 2016 at 1:43 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Mark - we already have MEFO and R5 ARD signature.
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> > > > > Tom/Mark. We need a NEW ENGLAND Project Leader signature on the attached signature sheet for the Lynx Project Plan. We never recieved one. Your ARD has signed. JB

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> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office

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Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Parkin, Mary
To: Zelenak, Jim
Cc: Bell, Heather; Cummings, Jonathan
Subject: Re: Hi Heidi! just found this, "mapping an argument" and thought you might find it interesting!
Date: Monday, April 25, 2016 3:19:41 PM

Oops, when I checked the calendar a little while ago, I saw the call wasn't on there, so I duplicated the last previous core team call I could find on the calendar, which began at 9:30 MT. I'll change it immediately, and I do plan to be on the call, Jim.

I'll spend some time later today (I have to leave for an appt now) getting the calendar invites up to speed. Will check with you, Jim, to make sure their correct.

Cheers,
Mary

On Mon, Apr 25, 2016 at 5:09 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> Not sure who among you plans to be on the core team call tomorrow, and I haven't heard back from core team members yet, but we will use the alternate number/passcode below.
>
> I've asked Core to be on the call at 10 AM Mountain Time.
>
> (b) (5) CIP
> passcode - (b) (5)
>
> On Mon, Apr 25, 2016 at 3:01 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:
>
> > Thanks, Heather. Will give this some thought before the core team call tomorrow.
> >
> > On Mon, Apr 25, 2016 at 2:10 PM, Bell, Heather <heather_bell@fws.gov> wrote:
> >
> > > > > http://decision-point.com.au/article/mapping-an-argument/
> > > > >
> > > > > i went on to links from there, but basically if we set up a template for the threats of say
> > > > > Contention (Changing climate will negatively affect Lynx occupation in the lower 48 over x timeframe),
> > > > > Argument (Lynx need snow, snow will decrease, therefore lynx will decrease in areas without snow),
> > > > > Evidence (models, literature, experts explained why we will lose snow, both supporting and detracting, obviously you would then say why the negative doesn't rise support the contention as well as the "supporting" evidence and why) and
> > > > > Source (citations for evidence)
> > > > >
> > > > > FEEL FREE TO REVISE!!!!!
> > > > >
> > > > > then give each team member the threats and deadlines!

Heather Bell
Ecological Services HQ
Division of Restoration and Recovery
SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff at https://sites.google.com/a/fws.gov/ssa/ and the REV Google Site: https://sites.google.com/a/fws.gov/rev/. For audiences outside FWS visit http://www.fws.gov/endangered/improving_ESA/SSA.html.

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Michelle Baker, PhD
The Conservation Writing Pro
Communication, the key to conservation
304 283 4573

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Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

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Jim Zelenak, Biologist
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Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Re: Core Team call tomorrow
Date: Monday, April 25, 2016 3:30:03 PM

Ignore the calendar invite - Mary said she will fix it after she gets back from an appointment.

On Mon, Apr 25, 2016 at 1:22 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Change in call-in info for tomorrow's call:
>
> (b) (5) CIP
> passcode (b) (5)
>
> On Mon, Apr 25, 2016 at 1:05 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Team:
> >
> > I hope you all will be able to dial in to a call/update tomorrow morning - I propose 10 AM Mountain Time, as we originally did for these calls. Please let me know if that works for you. If not, let me know a time that does.
> >
> > 866-857-8504
> > 7620543
> >
> > Look forward to catching up with everyone then.
> >
> > --
> > Jim Zelenak, Biologist
> > U.S. Fish and Wildlife Service
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
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> --
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U.S. Fish and Wildlife Service

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jim_zelenak@fws.gov

From: Smith, Tamara
To: Zelenak, Jim
Cc: Mark McCollough; Bryon Holt; Kurt Broderdorp
Subject: Re: Core Team call tomorrow
Date: Monday, April 25, 2016 4:15:44 PM

Hi Jim -

I am available to be on the call tomorrow morning at 10AM MT, if others are available then...

Thanks!
Tam

On Mon, Apr 25, 2016 at 2:22 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Change in call-in info for tomorrow's call:
>
> (b) (5) CIP
> passcode (b) (5)
>
> On Mon, Apr 25, 2016 at 1:05 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Team:
> >
> > I hope you all will be able to dial in to a call/update tomorrow morning - I propose 10 AM Mountain Time, as we originally did for these calls. Please let me know if that works for you. If not, let me know a time that does.
> >
> > (b) (5) CIP
> > (b) (5)
> >
> > Look forward to catching up with everyone then.
> >
> > --
> > Jim Zelenak, Biologist
> > U.S. Fish and Wildlife Service
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225 ext. 220
> > jim_zelenak@fws.gov
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext. 219 (new number)
952-646-2873 (new fax number)

612-600-1599 Cell

From:	Parkin, Mary
To:	Zelenak, Jim
Cc:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Jonathan Cummings; Heather Bell; Seth Willey; Jodi Bush
Subject:	Re: Lynx Core Team Call
Date:	Tuesday, April 26, 2016 8:25:55 AM

My calendar is set on ET, and I forgot to adjust. Sorry about that, folks.

On Tue, Apr 26, 2016 at 9:48 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> This is showing up on my calendar as 8 Am Mountain Time (a few minutes from now)- not sure why.
>
> The call is at 10 AM Mountain Time and only Core Team members need attend; others are welcome if they choose.
>
> (b) (5) CIP
> (b) (5)
>
> Thanks
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--

Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Bush, Jodi
To: Willey, Seth
Subject: Re: SIGNATURE NEEDED: Final Lynx Project Plan
Date: Tuesday, April 26, 2016 10:57:12 AM

---

thanks. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Tue, Apr 26, 2016 at 10:01 AM, Willey, Seth <seth_willey@fws.gov> wrote:

> **********
> Seth L. Willey, Branch Chief
> Regional Branch of Classification and Recovery
> Mountain-Prairie Region, USFWS
> Seth_Willey@fws.gov
> 303-236-4257
> **********
>
> On Mon, Apr 25, 2016 at 12:01 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> > here is the plan if you are missing it.
> >
> > Jodi L. Bush
> > Field Supervisor
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225, ext.205
> >
> > On Mon, Apr 25, 2016 at 12:01 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> > > We have everyone else's signature but Mike's. Can we get his so we can close this up?
> > > thanks. JB
> > >
> > > Jodi L. Bush
> > > Field Supervisor
> > > Montana Ecological Services Office
> > > 585 Shepard Way, Suite 1
> > > Helena, MT 59601
> > > (406) 449-5225, ext.205

On Fri, Jun 26, 2015 at 10:59 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

Attached is the final Lynx Project Plan for the SSA, Recovery Planning and Five-year Review in both word and pdf format. I am requesting via this email your signature on page 10 of that document. Comments on the draft project plan were received in late April and early May and we have incorporated those changes into the attached document.

For ease of collating signatures please use any of the following methods to add your signature to the document.

1. Open the attached pdf document in Adobe Reader. Click on the fill and sign tab and make a selection for your signature of the document. **Save and send back to Jim Zelenak.**

2. Sign a hardopy of the signature page (10), **scan and send back to Jim Zelenak.**

3. Add your signature in the word document by adding /s/ Your Name. **Save and send back to Jim Zelenak.**

You should have also received notice of what will be our monthly internal FWS coordination calls on the process from Jim Zelanak.
We will be conducting these calls the first tuesday of every month at 10am Mtn time.
Call in information is as follows: (b) (5) CIP, passcode: (b) (5) CIP

Shortly I will also be sending out another letter for our state partners. As we know, the States are particularly interested in being engaged in our Lynx recovery planning process. To that end, the letter updates where we are now and identifies a monthly coordination call with our state partners to keep them appraised of our progress. It would be helpful if versions of this state letter were sent out from your offices. Please use the version I provide to you as a template.

Thank you for your help and as always feel free to give me a call if you have questions or concerns. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Smith, Tamara
To: Zelenak, Jim
Cc: Mark McCollough; Kurt Broderdorp; Bryon Holt
Subject: Re: Lynx SSA Core Team call
Date: Monday, May 02, 2016 9:43:13 AM

Ok - sounds good.

On Mon, May 2, 2016 at 10:22 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> The all-FWS monthly call for tomorrow is cancelled - I sent an email a short while ago to that group.
>
> The Core Team call is not cancelled - we should catch-up tomorrow at usual time - 10 AM Mountain.
>
> On Mon, May 2, 2016 at 9:00 AM, Smith, Tamara <tamara_smith@fws.gov> wrote:
>
> > Is there an all FWS Lynx call at that time or was that cancelled also? Sorry if I missed it - just catching up on emails.
> >
> > On Mon, May 2, 2016 at 9:42 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Hi Team:
> > >
> > > I'd like to have a core team call tomorrow at our usual time of 10 AM Mountain Time.
> > >
> > > (b) (5) CIP
> > > (b) (5)
> > >
> > > Hope you all can make it.
> > >
> > > --
> > > Jim Zelenak, Biologist
> > > U.S. Fish and Wildlife Service
> > > Montana Ecological Services Office
> > > 585 Shepard Way, Suite 1
> > > Helena, MT 59601
> > > (406) 449-5225 ext. 220
> > > jim_zelenak@fws.gov
> >
> > --
> > Tamara Smith
> > U.S. Fish and Wildlife Service
> > Twin Cities Field Office
> > 4101 American Boulevard East
> > Bloomington, MN 55425
> > 952-252-0092, Ext. 219 (new number)
> > 952-646-2873 (new fax number)
> >
> > 612-600-1599 Cell

--

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--

Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext. 219 (new number)
952-646-2873 (new fax number)

612-600-1599 Cell

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Kurt Broderdorp; Bryon Holt
Subject: Lynx SSA Core Team call
Date: Monday, May 02, 2016 10:42:47 AM

Hi Team:

I'd like to have a core team call tomorrow at our usual time of 10 AM Mountain Time.

(b) (5)
Commerical
Information

Hope you all can make it.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Kurt Broderdorp
To: Jim Zelenak
Subject: RE: Core Team Call tomorrow
Date: Monday, May 09, 2016 3:36:40 PM

I will not be available, we are having an all hands meeting tomorrow and Wednesday.

Kurt Broderdorp
US Fish and Wildlife Service
(970) 628-7186

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Monday, May 09, 2016 2:49 PM
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Core Team Call tomorrow

Hi Team,

I'd like to have a call tomorrow at our usual time (10 Mountain) and number (b) (5) CIP (b) (5) CIP).

Let me know if you can or cannot make it.

I'd like to have everyone ready to discuss the current outline of the document on the drive - I've made some changes in trying to organize things - and to discuss the major gaps and how we best get them filled.

Would also like to touch on any responses to peer review "feelers" that folk shave been sending out, and whether/when we need to start letting RO folks know that we will need some level of in-house review before we go out to peer reviewers. I think Jodi has a plan for the latter, though I'm not certain of the details yet.

Also any thoughts/concerns you all may have.

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Kurt Broderdorp
To: Jim Zelenak
Subject: RE: Core Team Call tomorrow
Date: Monday, May 09, 2016 3:36:40 PM

I will not be available, we are having an all hands meeting tomorrow and Wednesday.

Kurt Broderdorp
US Fish and Wildlife Service
(970) 628-7186

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Monday, May 09, 2016 2:49 PM
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Subject: Core Team Call tomorrow

Hi Team,

I'd like to have a call tomorrow at our usual time (10 Mountain) and number (b) (5) CIP (b) (5) CIP).

Let me know if you can or cannot make it.

I'd like to have everyone ready to discuss the current outline of the document on the drive - I've made some changes in trying to organize things - and to discuss the major gaps and how we best get them filled.

Would also like to touch on any responses to peer review "feelers" that folk shave been sending out, and whether/when we need to start letting RO folks know that we will need some level of in-house review before we go out to peer reviewers. I think Jodi has a plan for the latter, though I'm not certain of the details yet.

Also any thoughts/concerns you all may have.

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Smith, Tamara
To: Zelenak, Jim
Cc: Mark McCollough; Bryon Holt; Kurt Broderdorp
Subject: Re: Core Team Call tomorrow
Date: Tuesday, May 10, 2016 7:50:38 AM

Hi Jim - I can be on the call...
Talk to you later - Tam

On Mon, May 9, 2016 at 3:48 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> I'd like to have a call tomorrow at our usual time (10 Mountain) and number ((b) (5) CIP).
>
> Let me know if you can or cannot make it.
>
> I'd like to have everyone ready to discuss the current outline of the document on the drive - I've made some changes in trying to organize things - and to discuss the major gaps and how we best get them filled.
>
> Would also like to touch on any responses to peer review "feelers" that folk shave been sending out, and whether/when we need to start letting RO folks know that we will need some level of in-house review before we go out to peer reviewers. I think Jodi has a plan for the latter, though I'm not certain of the details yet.
>
> Also any thoughts/concerns you all may have.
>
> Thanks.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext. 219 (new number)
952-646-2873 (new fax number)

612-600-1599 Cell

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Cc: Mary Parkin; Jonathan Cummings; Heather Bell; Jodi Bush
Subject: Lynx SSA call tomorrow
Date: Monday, May 16, 2016 1:45:15 PM

Hi All:

As I discussed last week with the Core Team, I'd like to have a call again this week and get back to weekly Core Team calls for the next little while to check-in on progress and clarify assignments, etc. as we try to get this SSA report wrapped up.

Because it's been a little while since we've had regular calls with the rest of the team, I thought we could have dual Core/Implementation teams call tomorrow, so I'm hoping Mary, Heather and Jonathan will be able to join and provide guidance on some parts of the documents and on getting the appropriate versions of the conceptual model(s) and summary tables finalized and ready to import to the report.

Anyway, Mary will send out a calendar invite soon, but please dial in at our normal Core Team time of 10 Mountain Time at the usual number/passcode:

(b) (5) CIP
(b) (5)

Look forward to talking with you all tomorrow.

Thanks,

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Google Calendar on behalf of Mary Parkin
To: mark_mccollough@fws.gov; tamara_smith@fws.gov; jim_zelenak@fws.gov; bryon_holt@fws.gov; kurt_broderdorp@fws.gov
Cc: heather_bell@fws.gov; jodi_bush@fws.gov; jwcummings@usgs.gov; seth_willey@fws.gov
Subject: Lynx SSA Core Team Call
Start: Tuesday, May 31, 2016 12:00:00 PM
End: Tuesday, May 31, 2016 1:00:00 PM
Location: (b) (5) CIP passcod (b) (5) C
Attachments: invite.ics

HYPERLINK "https://www.google.com/calendar/event?
action VIEW&eid cXA4cmczMDh2NW9rYzBsNWw3MjluYXMxb28gbWFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdml5NGZkNjMwM2MyYzRhOWYxZmI1NmQ5YTRiMzgzMjk2YTM5ODljYmY&ctz America/New_York&hl en"more details »

Lynx SSA Core Team Call

Weekly lynx core team calls through September.
When
Weekly from 12pm to 1pm on Tuesday from Tue May 31 to Tue Sep 27 Eastern Time
Where
(b) (5) CIP passcod (b) (5) C (HYPERLINK "https://maps.google com/maps?q 866-857-8504, passcode 7620543&hl en"map)
Calendar
mark_mccollough@fws.gov
Who
• mary_parkin@fws gov
- organizer, optional
• mark_mccollough@fws.gov
• tamara_smith@fws.gov
• jim_zelenak@fws.gov
• bryon_holt@fws.gov
• kurt_broderdorp@fws.gov
• heather_bell@fws.gov
- optional
• jodi_bush@fws.gov
- optional
• jwcummings@usgs.gov
- optional
• seth_willey@fws.gov
- optional

Going? All events in this series:
HYPERLINK "https://www.google.com/calendar/event?
action RESPOND&eid cXA4cmczMDh2NW9rYzBsNWw3MjluYXMxb28gbWFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&rst 1&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdml5NGZkNjMwM2MyYzRhOWYxZmI1NmQ5YTRiMzgzMjk2YTM5ODljYmY&ctz America/New_York&hl en"Yes - HYPERLINK "https://www.google.com/calendar/event?
action RESPOND&eid cXA4cmczMDh2NW9rYzBsNWw3MjluYXMxb28gbWFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&rst 3&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdml5NGZkNjMwM2MyYzRhOWYxZmI1NmQ5YTRiMzgzMjk2YTM5ODljYmY&ctz America/New_York&hl en"Maybe - HYPERLINK "https://www.google.com/calendar/event?
action RESPOND&eid cXA4cmczMDh2NW9rYzBsNWw3MjluYXMxb28gbWFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&rst 2&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdml5NGZkNjMwM2MyYzRhOWYxZmI1NmQ5YTRiMzgzMjk2YTM5ODljYmY&ctz America/New_York&hl en"No HYPERLINK "https://www google.com/calendar/event?
action VIEW&eid cXA4cmczMDh2NW9rYzBsNWw3MjluYXMxb28gbWFya19tY2NvbGxvdWdoQGZ3cy5nb3Y&tok MTkjbWFyeV9wYXJraW5AZndzLmdvdml5NGZkNjMwM2MyYzRhOWYxZmI1NmQ5YTRiMzgzMjk2YTM5ODljYmY&ctz America/New_York&hl en"more options »

Invitation from HYPERLINK "https://www.google.com/calendar/"Google Calendar

You are receiving this email at the account mark_mccollough@fws.gov because you are subscribed for invitations on calendar mark_mccollough@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. HYPERLINK "https://support.google.com/calendar/answer/37135#forwarding"Learn More.

From: Zelenak, Jim
To: Parkin, Mary
Subject: Re: Lynx SSA Calendar Invites
Date: Monday, June 06, 2016 11:16:17 AM

Hi Mary,

Jodi has recommended that we keep the internal FWS updates separate from the state coordination calls.

Given that, could you send a calendar reminder/invite for tomorrow, Tues. June 7, 10 AM Mountain Time to the email list below, and include the title call-in info here?:

Title: Lynx SSA Coordination Call - Internal FWS
(b) (5) CIP
Passcode: (b) (5)

I suspect a very quick call to let folks know where we're at with the SSA report (scrambling to finish it) and to see if folks have questions.

If I don't hear back from you (if you are traveling, on leave, or otherwise occupied), by about 2-3 today, i will just send an email.

Thanks,

Jim

On Wed, May 25, 2016 at 4:09 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Done! Have a relaxing evening,
> Mary
>
> On Wed, May 25, 2016 at 5:23 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Mary,
> >
> > Thanks for your time on the phone. As we discussed:
> >
> > 1. From now thru end of Sept., could you put weekly core team calls at 10-11 AM Mountain Time every Tuesday on calendars for me, Mark, Tam, Bryon and Kurt, with optional attendance/ notification for you, Heather, Jonathan, Seth, and Jodi?
> >
> > Title: Lynx SSA Core Team Call
> > (b) (5) CIP
> > Passcode: (b) (5)
> >
> > 2. Also thru end of Sept., could you put monthly (last Wednesday of each month) state coordination call, 1-2 PM Mountain Time, on calendars of USFWS folks below?
> >
> > Title: Lynx SSA State Coordination Call
> > 866-822-7385
> > Passcode: 5396168
> >
> > Seth Willey <Seth_Willey@fws.gov>, Jodi Bush <jodi_bush@fws.gov>, Heather Bell <heather_bell@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Jonathan Cummings <jwcummings@usgs.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Brady McGee

<brady_mcgee@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Lisa Solberg Schwab <lisa_solbergschwab@fws.gov>, Ann Timberman <ann_timberman@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Brad Thompson <brad_thompson@fws.gov>, Chris Mensing <chris_mensing@fws.gov>, David Stilwell <David_Stilwell@fws.gov>, Drue DeBerry <drue_deberry@fws.gov>, Eric Rickerson <eric_rickerson@fws.gov>, Grant Canterbury <Grant_Canterbury@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Karl Halupka <Karl_Halupka@fws.gov>, Kate Novak <kate_novak@fws.gov>, Kim Garner <kim_garner@fws.gov>, Larry Crist <Larry_Crist@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Leslie Ellwood <leslie_ellwood@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Martin Miller <Martin_Miller@fws.gov>, Megan Kosterman <megan_kosterman@fws.gov>, Michelle Eames <michelle_eames@fws.gov>, Paul Casey <paul_casey@fws.gov>, Paul Henson <paul_henson@fws.gov>, Peter Fasbender <peter_fasbender@fws.gov>, Rollie White <rollie_white@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Scott Hicks <scott_hicks@fws.gov>, Sue Livingston <sue_livingston@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Tyler Abbott <Tyler_Abbott@fws.gov>, Wally Murphy <wally_murphy@fws.gov>, Dennis Mackey <Dennis_Mackey@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>,Gary Miller <gary_miller@fws.gov>, Karen Cathey <karen_cathey@fws.gov>, Steve Spangle <steve_spangle@fws.gov>

After I talk with Jodi, we can decide about the first-Tues. monthly internal FWS update/coordination calls, but that would be for the same list of FWS folks.

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

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Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Anthony Tur; Brad Thompson; Chris Mensing; David Stilwell; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Karl Halupka; Kate Novak; Kim Garner; Larry Crist; Laura Ragan; Leslie Ellwood; Mark Maghini; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tyler Abbott; Wally Murphy; Dennis Mackey; Patricia Zenone; Gary Miller; Karen Cathey; Steve Spangle
Subject:	Reminder: Lynx SSA Internal Coordination Call
Date:	Monday, June 06, 2016 5:42:37 PM

Hi All:

Our monthly Lynx SSA FWS coordination call/update is scheduled for tomorrow, Tues. June 7, 10 AM Mountain Time. Call-in info below.

(b) (5) CIP

Passcode: (b) (5) CIP

I anticipate a very quick call to let folks know where we're at with the SSA report (scrambling to finish the draft) and to see if folks have questions.

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Mary Parkin; Jonathan Cummings; Heather Bell; Jodi Bush; Seth Willey
Subject:	Re: Lynx SSA Core/FIT call
Date:	Tuesday, June 21, 2016 10:52:22 AM

Hi All:

Hope Core Team can make the call this morning at 10 Mountain Time. FIT Team and managers welcome, too. Will have a quick rundown on where we are with the SSA Report and what sections remain to complete; other items as necessary.

(b) (5) CIP
(b) (5)

On Mon, Jun 13, 2016 at 1:16 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> Just a note to let folks know I'll be out of the office tomorrow, 6/14, and for the following 5 work days, so unable to lead/participate in the regularly-scheduled Tues. morning SSA call.
>
> I'll be back next Tues., 6/21, and will plan on having the normal call (10 AM Mountain Time) then.
>
> I appreciate Core Team folks' continued work on finalizing/tightening-up their sections of the draft report.
>
> If anyone is up to it, I feel like the first 2 chapters are ready for review, although we still need to decide which graphics to use and where.
>
> Still some work needed to fill holes, mostly mine, in the remaining chapters, which I'll continue to work on.
>
> Thanks,
>
> Jim
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: McCollough, Mark
Subject: Re: Lynx SSA Core/FIT call
Date: Wednesday, June 22, 2016 2:54:38 PM

It was nice to step away from the SSA for almost a week. I did not take my computer along, and I slept better most nights than I have at home lately. It was also nice to see friends and family again, and for Abby to "meet" some of her cousins who haven't' seen her since she was 2 (and of course she has no memories of that).

I never did get to see small-whorled pogonia in WV - I think there were only a very few known occurrences in the state...

No need to apologize - you've already done more than your share on the SSA, and I know you have other responsibilities. Bryon and Kurt also could not be on the call, so it was a brief discussion with Tam, Mary and Jonathan. I've been meaning to send an email to let you and the others know what we discussed and to get some thoughts on time lines for having sections finished.

If I'm disappointed in anything, it is in my own inability to pull this document toward some semblance of completion. I'm still struggling to write some of the pop. requirements section and to get thru Ch. 3, 4 and 5. Not sure why, but writing this is like pulling teeth for me lately. Every time I make a little progress, i think of other details/nuances that seem important to discuss.

I don't have any requests for additional particular work - I guess if you have time and feel inclined you could work on polishing the fragmentation section - I have not had a chance to carefully review what you put together there (or your other sections for that matter).

I will send a follow-up email to the Core Team in a few minutes asking everyone to have their Ch. 4 and 5 sections finished and as tight and concise as possible by the end of next week (that's when Tam thought she might have time to get hers done). It looks like you are mostly done, maybe completely, but if you have time to edit out any redundancies and tighten things up, that would be great. I don't anticipate me or the others going into the level of detail you provided for your unit. At some point, we will likely have to edit for consistency among units, but I can't worry about that at the moment.

Wish I was joining you at NCTC for the climate change course.

Thanks for your continuing efforts Mark.

Jim

On Wed, Jun 22, 2016 at 10:07 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Jim: I hope you had a good week away from the SSA.
>
> My apologies that I could not participate yesterday. I was on a site visit with Federal Aid and state biologist at some small whorled pogonia sites in southern Maine.
>
> You probably were disappointed to see that I did not make much progress on the SSA while you were gone. I did draft a fragmentation section.
>
> We have a new supervisor-of-the-month who raised her eyebrows when I said I had set aside a BA from early April from USDA APHIS for their mammal trapping program in ME, VT, NH (consultation on lynx). So, I've had to work on that last week. The document was in rough shape and likely needs to be redeveloped as a programmatic consultation on a wide variety of animal damage control and rabies projects. I still need another day or two to

complete. I also have a draft EA from April from the Corps for a piping plover beach that needs a response. In other words, work has backed up because of the SSA and I need to do some things to ease the pressure.

I hope to be back to SSA work next week.

Let me know if there is anything in particular you would like me to work on.

I will be gone to NCTC for a climate change class (that I hope will help with the lynx and Furbish's lousewort SSAs) the week of July 11. I will be taking the next week for annual leave to visit my parents in PA.

Mark

On Tue, Jun 21, 2016 at 10:52 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> Hope Core Team can make the call this morning at 10 Mountain Time. FIT Team and managers welcome, too. Will have a quick rundown on where we are with the SSA Report and what sections remain to complete; other items as necessary.
>
> (b) (5) CIP
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> > Hi All:
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> > I'll be back next Tues., 6/21, and will plan on having the normal call (10 AM Mountain Time) then.
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> > Still some work needed to fill holes, mostly mine, in the remaining chapters, which I'll continue to work on.
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> > Thanks,
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> > Jim
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> Jim Zelenak, Biologist
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jim_zelenak@fws.gov

--
Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 469-7300, Extension 1115
Fax: (207) 469-6725
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Kurt Broderdorp
To: Jim Zelenak; Mark McCollough; Tamara Smith; Bryon Holt
Cc: Mary Parkin; Jonathan Cummings; Heather Bell
Subject: RE: Core Team Call
Date: Tuesday, June 28, 2016 8:19:56 AM

I am available.

Kurt Broderdorp
US Fish and Wildlife Service
(970) 628-7186

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, June 28, 2016 8:08 AM
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Cc: Mary Parkin; Jonathan Cummings; Heather Bell
Subject: Core Team Call

Hi Team,

Hope you can dial in for a quick core team call today at the usual time (10 AM Mountain) and number:

(b) (5) CIP
(b) (5)
CIP

FIT folks are welcome to join also.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Google Calendar on behalf of Mary Parkin
To: mark_mccollough@fws.gov
Subject: Lynx SSA Core Team Call
Attachments: invite.ics

This event has been canceled and removed from your calendar.

Lynx SSA Core Team Call

Weekly lynx core team calls through September.
When
Tue Jul 5, 2016 12pm – 1pm Eastern Time
Where
[redacted], passcode [redacted] (HYPERLINK "https://maps.google.com/maps?q=(b) (5) Commerical l f ti &hl=en"map)
Calendar
mark_mccollough@fws.gov
Who
• mary_parkin@fws.gov
- organizer, optional
• mark_mccollough@fws.gov
• kurt_broderdorp@fws.gov
• jim_zelenak@fws.gov
• tamara_smith@fws.gov
• bryon_holt@fws.gov
• jwcummings@usgs.gov
- optional
• jodi_bush@fws.gov
- optional
• heather_bell@fws.gov
- optional
• seth_willey@fws.gov
- optional
Invitation from HYPERLINK "https://www.google.com/calendar/"Google Calendar

You are receiving this email at the account mark_mccollough@fws.gov because you are subscribed for cancellations on calendar mark_mccollough@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. HYPERLINK "https://support.google.com/calendar/answer/37135#forwarding"Learn More.

From: Cummings, Jonathan
To: Zelenak, Jim
Cc: Mark McCollough; Tamara Smith; Kurt Broderdorp; Bryon Holt; Jodi Bush; Mary Parkin; Heather Bell
Subject: Re: Lynx SSA Call
Date: Monday, July 25, 2016 6:46:59 PM

I'm working on the SSA review between my travels. I should have Ch. 3 to you some time soon. With my travel, and without Ch. 6 (and the portions of 4 and 5 that most closely support Ch. 6) complete I'm going to hold off on reviewing those until they are complete and I'm through travels (I return August 8th).

In regards to figures, there is room for updating the conceptual models to match the text and simplify them (e.g., removing the demographic portion of the resiliency diagram). I would encourage a summary table of current condition in some form, whether the one developed in Denver or an adaptation the team develops.

I wont be able to join the calls this week or next, but can comment via email if you want my input on anything.

Jonathan

On Mon, Jul 25, 2016 at 2:53 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Teams,
>
> Seems like a while since more than a few of us were available for a lynx call/update, but I'm hoping most will be able to join the call tomorrow, 7/26, at 10 AM Mountain Time. We talked a while back about combining the Core and FIT Team calls, and that's sort of what we did for the last few weeks.
>
> As folks who have been in the draft report on the drive can see, I'm still struggling to fill in remaining sections. For the call tomorrow, I'd like to talk about Core Team review of the first 3 Chapters, with each member then checking their Ch. 4 and 5 sections looking to remove and redundancy. I'd also like Core Team to ensure that template topics for each section (Ch. 4 and 5) have been addressed and that expert workshop results for their unit have been summarized and pulled into Ch. 5, along with the probability of persistence graph from the workshop report.
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> I'd also like to talk about and settle on which figures (conceptual models and others) we should use and where, whether any need to be changed/refined, and whether other tables are needed and where (e.g., some version of the current conditions table that we worked on in Denver?).
>
> I'm sure there are other things to talk about. If you have specific issues you'e like to address, you can let me know ahead of time or just bring up on the call.
>
> Talk to you tomorrow.
>
> (b) (5) CIP
> (b) (5)
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601

(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--

Jonathan W. Cummings, PhD
Research Ecologist
USGS - Patuxent Wildlife Research Center (remotely located)
12100 Beech Forest Road
Laurel, MD 20708 USA
jwcummings@usgs.gov
https://profile.usgs.gov/jwcummings

Remote Contact Info:
Ph: 802-999-8684
243 Locust St
Dover, NH 03820

From: McCollough, Mark
To: Zelenak, Jim
Subject: Re: Lynx SSA Call
Date: Tuesday, July 26, 2016 8:28:50 AM

Jim:

I will be on the call today and ready to dive back into the SSA. Sorry for my absence the last 2 or 3 weeks.

I still have a backlog of section 7 consultations hanging over my head and I am still required to work on sorting out our office files - left in shambles by the mover. There's just not enough hours in the day.

Mark

On Mon, Jul 25, 2016 at 4:53 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Teams,
>
> Seems like a while since more than a few of us were available for a lynx call/update, but I'm hoping most will be able to join the call tomorrow, 7/26, at 10 AM Mountain Time. We talked a while back about combining the Core and FIT Team calls, and that's sort of what we did for the last few weeks.
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--
Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 469-7300, Extension 1115
Fax: (207) 469-6725
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Kurt Broderdorp; Bryon Holt
Cc:	Jodi Bush; Mary Parkin; Heather Bell; Jonathan Cummings
Subject:	Re: Lynx SSA Call
Date:	Tuesday, July 26, 2016 2:26:11 PM

Thanks for you time and contributions on the call today.

Heather asked that I follow up with an email about assignments we discussed for Core Team, so:

1. Make sure your unit parts of chapters 4 and 5 are as tight as you can make them, addressing the template items for each. In Ch. 5, the last part of the unit-specific sections should be "lynx viability" - where you should summarize the expert workshop results and import the probability of persistence graph for your unit and discuss if need be. Tam has already take a stab at this, so take a look at her Ch. 5/Unit 2.

2. Review and comment on Chapters 1-3 with an eye to anything that might be repeated in later chapters - if so, look for opportunities to reduce redundancy by referring to the earlier sections if appropriate/applicable.

3. Review figures/conceptual models and make any comments/suggestions that you think might improve them (except for the map, which we've already discussed and will work thru another time soon).

4. Also see (at link below to the drive) the spreadsheet Jonathan pulled together while we were working on a current conditions table in Denver: Take a look at the various sheets and think about how we might generate a table that would be useful in the SSA report (at the end of Ch. 4). I'd welcome thoughts on or efforts at turning it into a table for the report.

https://docs.google.com/spreadsheets/d/1BkxJiAfXH4QyqXv86A-Bj0VBfHyTJtwQXBd9Le0giZw/edit#gid=1917623158

4. Provide bullets or general thoughts for the DPS-wide summaries at the ends of Ch. 4 and 5, and for the synthesis section.

5. As Kurt mentioned, make sure you add any new citations to the list and move pdfs to the drive (only docs that are not already in the LCAS 2013 lit cited file).

I'm probably forgetting something, but I think that's most of it.

I'll send out a reminder for the state coordination call tomorrow and hope you can join that, too.

Thanks again.

Jim

On Mon, Jul 25, 2016 at 2:53 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Teams,
>
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Talk to you tomorrow.

(b) (5) CIP
(b) (5)

--
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jim_zelenak@fws.gov

From: Murphy, Wally
To: Jodie Smithem; Patricia Zenone
Subject: Fwd: Reminder - Lynx SSA Monthly FWS Coordination Call
Date: Monday, August 01, 2016 1:43:06 PM

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Mon, Aug 1, 2016 at 1:35 PM
Subject: Reminder - Lynx SSA Monthly FWS Coordination Call
To: Seth Willey <Seth_Willey@fws.gov>, Jodi Bush <jodi_bush@fws.gov>, Heather Bell <heather_bell@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Jonathan Cummings <jwcummings@usgs.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Brady McGee <brady_mcgee@fws.gov>, Jeffrey Dillon <jeffrey_dillon@fws.gov>, Lisa Solberg Schwab <lisa_solbergschwab@fws.gov>, Ann Timberman <ann_timberman@fws.gov>, Anthony Tur <Anthony_Tur@fws.gov>, Brad Thompson <brad_thompson@fws.gov>, Chris Mensing <chris_mensing@fws.gov>, David Stilwell <David_Stilwell@fws.gov>, Drue DeBerry <drue_deberry@fws.gov>, Eric Rickerson <eric_rickerson@fws.gov>, Grant Canterbury <Grant_Canterbury@fws.gov>, Jeff Krupka <jeff_krupka@fws.gov>, Karl Halupka <Karl_Halupka@fws.gov>, Kate Novak <kate_novak@fws.gov>, Kim Garner <kim_garner@fws.gov>, Larry Crist <Larry_Crist@fws.gov>, Laura Ragan <Laura_Ragan@fws.gov>, Leslie Ellwood <leslie_ellwood@fws.gov>, Mark Maghini <mark_maghini@fws.gov>, Martin Miller <Martin_Miller@fws.gov>, Megan Kosterman <megan_kosterman@fws.gov>, Michelle Eames <michelle_eames@fws.gov>, Paul Casey <paul_casey@fws.gov>, Paul Henson <paul_henson@fws.gov>, Peter Fasbender <peter_fasbender@fws.gov>, Rollie White <rollie_white@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Scott Hicks <scott_hicks@fws.gov>, Sue Livingston <sue_livingston@fws.gov>, Tom Chapman <Tom_Chapman@fws.gov>, Tyler Abbott <Tyler_Abbott@fws.gov>, Wally Murphy <wally_murphy@fws.gov>, Dennis Mackey <Dennis_Mackey@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>, Gary Miller <gary_miller@fws.gov>, Karen Cathey <karen_cathey@fws.gov>, Steve Spangle <steve_spangle@fws.gov>

Hi All:

We will have a quick update on the lynx SSA tomorrow at 10 AM Mountain Time.

(b) (5) CIP

Passcode: (b) (5) CIP

Thanks.

--
Jim Zelenak, Biologist
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Montana Ecological Services Office
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Helena, MT 59601

(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Wally Murphy
NMESFO Supervisor
505/761-4781
CP 505/480-4821

'it had long since come to my attention that people of accomplishment rarely sat back and let things happen to them. They went out and happened to things." Leonardo Da Vinci

From: Zelenak, Jim
To: Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Anthony Tur; Brad Thompson; Chris Mensing; David Stilwell; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Karl Halupka; Kate Novak; Kim Garner; Larry Crist; Laura Ragan; Leslie Ellwood; Mark Maghini; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tyler Abbott; Wally Murphy; Dennis Mackey; Patricia Zenone; Gary Miller; Karen Cathey; Steve Spangle
Subject: Reminder - Lynx SSA Monthly FWS Coordination Call
Date: Monday, August 01, 2016 3:36:01 PM

Hi All:

We will have a quick update on the lynx SSA tomorrow at 10 AM Mountain Time.

(b) (5) CIP

Passcode: (b) (5) CIP

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Kurt Broderdorp; Bryon Holt
Subject: Re: Core Team Call Today
Date: Tuesday, August 09, 2016 10:37:56 AM

Here's the link to wolf SSA.

https://www.fws.gov/alaska/fisheries/endangered/pdf/aa_wolf/AA_wolf_SSA_Final.pdf

On Tue, Aug 9, 2016 at 8:36 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> We have our weekly call today at 10 Mountain Time.
>
> Usual number and passcode:
>
> (b) (5) CIP
> (b) (5)
>
> I will send another reminder of the call to the others - FIT Team, Jodi, Seth (and you all again) after this one.
>
> Jodi and I talked yesterday, and she wants me to hand her something to review by COB today, recognizing that there still will be some gaps - (mine). She recognizes the time line issues and is concerned. I also let her know that I was struggling with getting the doc finished, and she thinks I'm too worried about perfecting/polishing things, and asked me to fill as much of the gaps as I can - which is my goal today. She also sees that I'm stressed, have been working weekends and not sleeping too well - so she has asked me to step away from it for a few days after I give it to her at the end of the day today. So I will do that.
>
> Anyway, you all have filled in your parts, please make sure you feel they are ready for the first step of internal FWS review.
>
> Also, on last week's call, I requested that each member pull together a summary paragraph or bullets for their unit for the summary/DPS-wide wrap-up for both Ch. 4 and Ch. 5 - your most important points for the current and future condition for your unit. Please see what Mark and Tam have done for sections 4.2 and 5.2, and try to add your summaries/bullets by COB today.
>
> Mark and I also discussed some potentially useful table/summary templates from the recent Alexander Archipelago Wolf SSA (link below), and Mark will be working today on pulling those into the lynx drive document today. See pages 123-127 of the wolf SSA and start thinking about what info you could contribute based on your unit assessment to tables similar to 26 and 27 in the wold doc.
>
> Thanks
>
> Talk to you all soon.
>
> --
> Jim Zelenak, Biologist
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jim_zelenak@fws.gov

From: Zelenak, Jim
To: Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Kurt Broderdorp; Mark McCollough; Tamara Smith; Bryon Holt
Subject: Lynx SSA Call Today
Date: Tuesday, August 09, 2016 10:43:03 AM

Hi Team,

We have our weekly call today at 10 Mountain Time.

Jodi and I will discuss where we're at and how we might best move forward. Mark and I will discuss some potentially useful templates from the Alexander Archipelago Wolf SSA that might be useful in helping us wrap things up. We've been talking particularly about pp. 123-127 of the wolf SSA. Take a look if you are interested:

https://www.fws.gov/alaska/fisheries/endangered/pdf/aa_wolf/AA_wolf_SSA_Final.pdf

Usual number and passcode:

(b) (5) CIP
(b) (5)
CIP

Talk to you all in a bit.

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Parkin, Mary
To:	Zelenak, Jim
Cc:	Seth Willey; Jodi Bush; Heather Bell; Jonathan Cummings; Kurt Broderdorp; Mark McCollough; Tamara Smith; Bryon Holt
Subject:	Re: Lynx SSA Call Today
Date:	Tuesday, August 09, 2016 12:03:28 PM

Hi Jim,

First, I plan to be on the call but may be a tad late, as I need to pick up my son from therapy right around then.

Second, apologies for not getting further in my review to date. I've been swamped by another time-sensitive project (these days it seems to be a matter of trading off between one urgent project and another), but will continue reviewing as quickly as possible.

Third, the wolf SSA report looks like the best example so far for the lynx. The tables laying out the evidence and uncertainties relative to the 3Rs are particularly useful.

Talk with you all soon,
Mary

On Tue, Aug 9, 2016 at 10:42 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> We have our weekly call today at 10 Mountain Time.
>
> Jodi and I will discuss where we're at and how we might best move forward. Mark and I will discuss some potentially useful templates from the Alexander Archipelago Wolf SSA that might be useful in helping us wrap things up. We've been talking particularly about pp. 123-127 of the wolf SSA. Take a look if you are interested:
>
> https://www.fws.gov/alaska/fisheries/endangered/pdf/aa_wolf/AA_wolf_SSA_Final.pdf
>
> Usual number and passcode:
>
> (b) (5) CIP
> (b) (5)
> CIP
>
> Talk to you all in a bit.
>
> Thanks.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Kurt Broderdorp; Bryon Holt; Jodi Bush; Mary Parkin; Heather Bell; Jonathan Cummings
Subject: Fwd: Invitation for Instant Net Conference
Date: Monday, August 22, 2016 4:00:31 PM

Hi All:

We'll try a webinar tomorrow in the hope that it will help with the lynx SSA work session.

Usual conference line and passcode:

(b) (5) CIP
passcode (b) (5) CIP

---------- Forwarded message ----------
From: <e-meetings@mymeetings.com>
Date: Mon, Aug 22, 2016 at 1:30 PM
Subject: Invitation for Instant Net Conference
To: jim_zelenak@fws.gov

You are invited to join a meeting hosted by Jim Zelenak. Meeting details are listed below.

Meeting Date: 08/23/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: 446939152
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220

jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Mary Parkin; Heather Bell; Jonathan Cummings; Justin Shoemaker
Cc:	Jodi Bush; Seth Willey
Subject:	Fwd: Invitation for Instant Net Conference
Date:	Monday, September 12, 2016 3:36:36 PM

Hi All:

This is a reminder for tomorrow's weekly Lynx SSA Core/FIT Teams call and webinar. We will be going through the draft doc on the drive trying to finish changes so it will be ready to go out for internal FWS review very soon.

Webinar instructions below. Usual conference number and passcode - you should have them on your calendar, too:

(b) (5) CIP
passcode(b) (5)

Hope you all can join.

Thanks,

Jim

---------- Forwarded message ----------
From: <e-meetings@mymeetings.com>
Date: Mon, Sep 12, 2016 at 1:17 PM
Subject: Invitation for Instant Net Conference
To: jim_zelenak@fws.gov

You are invited to join a meeting hosted by BRENT ESMOIL. Meeting details are listed below.

Meeting Date: 09/13/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Mary Parkin; Heather Bell; Jonathan Cummings; Justin Shoemaker
Cc: Jodi Bush; Seth Willey
Subject: Re: Invitation for Instant Net Conference
Date: Monday, September 19, 2016 4:49:24 PM

Hi All:

After talking briefly with Justin, we thought it would be good to have the Core Team (as well as FIT) on the call tomorrow (Sept. 20) so everyone is up to date, we can talk about what remains to be reviewed by the Core Team before the draft SSA report is ready for broader internal Service review, and our options for progress given the access/editing challenges on Google Drive.

Core Team also needs to discuss several of the draft tables currently in the doc.

So please join the call if you can. 10 AM Mountain Time, usual number and passcode:

(b) (5) CIP
Passcode (b) (5) CIP

We will also have the webinar up so we can work through the document together (likely a word version given access issues). Webinar access information at bottom.

Hope Core and FIT members can attend.

Thanks,

On Mon, Sep 12, 2016 at 1:36 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> This is a reminder for tomorrow's weekly Lynx SSA Core/FIT Teams call and webinar. We will be going through the draft doc on the drive trying to finish changes so it will be ready to go out for internal FWS review very soon.
>
> Webinar instructions below. Usual conference number and passcode - you should have them on your calendar, too:
>
> (b) (5) CIP
> passcode (b) (5) CIP
>
> Hope you all can join.
>
> Thanks,
>
> Jim
>
> ---------- Forwarded message ----------
> From: <e-meetings@mymeetings.com>
> Date: Mon, Sep 12, 2016 at 1:17 PM
> Subject: Invitation for Instant Net Conference

To: jim_zelenak@fws.gov

You are invited to join a meeting hosted by BRENT ESMOIL. Meeting details are listed below.

Meeting Date: 09/

20/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Parkin, Mary
To:	Zelenak, Jim
Cc:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Heather Bell; Jonathan Cummings; Justin Shoemaker; Jodi Bush; Seth Willey
Subject:	Re: Invitation for Instant Net Conference
Date:	Tuesday, September 20, 2016 8:40:40 AM

Hi Jim and all,

I won't be able to make the call and the Executive Summary is still in process, but I think this is the least important thing to discuss at this point!

I'll try to catch up with you before I head out (of the country) next week.

Cheers,
Mary

On Mon, Sep 19, 2016 at 4:49 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> After talking briefly with Justin, we thought it would be good to have the Core Team (as well as FIT) on the call tomorrow (Sept. 20) so everyone is up to date, we can talk about what remains to be reviewed by the Core Team before the draft SSA report is ready for broader internal Service review, and our options for progress given the access/editing challenges on Google Drive.
>
> Core Team also needs to discuss several of the draft tables currently in the doc.
>
> So please join the call if you can. 10 AM Mountain Time, usual number and passcode:
>
> (b) (5) CIP
> Passcode (b) (5) CIP
>
> We will also have the webinar up so we can work through the document together (likely a word version given access issues). Webinar access information at bottom.
>
> Hope Core and FIT members can attend.
>
> Thanks,
>
> On Mon, Sep 12, 2016 at 1:36 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi All:
> >
> > This is a reminder for tomorrow's weekly Lynx SSA Core/FIT Teams call and webinar. We will be going through the draft doc on the drive trying to finish changes so it will be ready to go out for internal FWS review very soon.
> >
> > Webinar instructions below. Usual conference number and passcode - you should have them on your calendar, too:

(b) (5) CIP

passcode (b) (5)

Hope you all can join.

Thanks,

Jim

---------- Forwarded message ----------
From: <e-meetings@mymeetings.com>
Date: Mon, Sep 12, 2016 at 1:17 PM
Subject: Invitation for Instant Net Conference
To: jim_zelenak@fws.gov

You are invited to join a meeting hosted by BRENT ESMOIL. Meeting details are listed below.

Meeting Date: 09/

20/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

From:	Stephanie Potter
Cc:	Marilet Zablan; Alisa Shull; Martin Miller
Subject:	Lynx SSA Briefing
Start:	Friday, October 14, 2016 5:00:00 PM
End:	Friday, October 14, 2016 6:00:00 PM
Location:	RD conference room for RO staff call in (b) (5) CIP PC (b) (5) CIP (Noreen only (b) (5) CIP)

I will update meeting once we receive webinar info from Marj

From:	Zelenak, Jim
To:	Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Anthony Tur; Brad Thompson; Chris Mensing; David Stilwell; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Karl Halupka; Kate Novak; Kim Garner; Larry Crist; Laura Ragan; Leslie Ellwood; Mark Maghini; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tyler Abbott; Wally Murphy; Dennis Mackey; Patricia Zenone; Gary Miller; Karen Cathey; Steve Spangle; Tom McDowell
Subject:	Re: Lynx SSA Internal FWS coordination call - rescheduled
Date:	Tuesday, October 11, 2016 10:01:12 AM

Hi All:

We will have a quick update/ coordination call at 10 AM Mountain Time.

(b) (5) CIP
passcode: (b) (5) CIP

Thanks.

On Tue, Oct 4, 2016 at 9:04 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All,
>
> Sorry for the late notice, but we need to cancel the lynx SSA call normally scheduled for today (first Tues. monthly) and reschedule for next Tues., Oct. 11 - same time, 10 AM Mountain Time.
>
> I will send a reminder along with number and pass code before then.
>
> Thanks.
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Stephanie Potter
To:	Michael Thabault; Seth Willey; Marjorie Nelson; Jodi Bush; Justin Shoemaker; Tom Melius; Robyn Thorson; Wendi Weber; Theresa Rabot; Sarah Hall; Jim Zelenak
Cc:	Alisa Shull; Martin Miller; Marilet Zablan
Subject:	Lynx SSA Briefing
Start:	Tuesday, October 18, 2016 1:00:00 PM
End:	Tuesday, October 18, 2016 2:00:00 PM
Location:	RD conference room for RO staff call in (b) (5) CIP PC (b) (5) CIP (Noreen only (b) (5) CIP)

I will update meeting once we receive webinar info from Marj

From:	Stephanie Potter
To:	Michael Thabault; Seth Willey; Marjorie Nelson; Jodi Bush; Justin Shoemaker; Tom Melius; Robyn Thorson; Wendi Weber; Theresa Rabot; Sarah Hall; Jim Zelenak; Heather Bell; Bryon Holt; Mark McCollough; Tamara Smith; Kurt Broderdorp; Mary Parkin; Jonathan Cummings
Cc:	Alisa Shull; Martin Miller; Marilet Zablan
Subject:	Lynx SSA Briefing
Start:	Tuesday, October 18, 2016 1:00:00 PM
End:	Tuesday, October 18, 2016 2:00:00 PM
Location:	RD conference room for RO staff call in (b) (5) CIP PC (b) (5) CIP (Noreen only (b) (5) CIP)

From: <HYPERLINK "mailto:e-meetings@mymeetings com"e-meetings@mymeetings.com>
Date: Thu, Oct 13, 2016 at 10:43 AM
Subject: Invitation for Instant Net Conference
To: HYPERLINK "mailto:jim_zelenak@fws.gov"jim_zelenak@fws.gov

You are invited to join a meeting hosted by Jodi Bush. Meeting details are listed below.

Meeting Date: 10/18/2016

Meeting Time: 1:00 PM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP

Meeting Passcode:

Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:

(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP

2. Enter the required fields.

3. Indicate that you have read the Privacy Policy.

4. Click on Proceed.

From:	Stephanie Potter
To:	Michael Thabault; Seth Willey; Marjorie Nelson; Jodi Bush; Justin Shoemaker; Tom Melius; Robyn Thorson; Wendi Weber; Theresa Rabot; Sarah Hall; Jim Zelenak; Heather Bell; Bryon Holt; Mark McCollough; Tamara Smith; Kurt Broderdorp; Mary Parkin; Jonathan Cummings
Cc:	Alisa Shull; Martin Miller; Marilet Zablan
Subject:	Lynx SSA Briefing
Start:	Tuesday, October 18, 2016 3:00:00 PM
End:	Tuesday, October 18, 2016 4:00:00 PM
Location:	RD conference room for RO staff call in (b) (5) CIP PC (b) (5) CIP (Noreen only (b) (5) CIP)

From: <HYPERLINK "mailto:e-meetings@mymeetings com"e-meetings@mymeetings.com>
Date: Thu, Oct 13, 2016 at 10:43 AM
Subject: Invitation for Instant Net Conference
To: HYPERLINK "mailto:jim_zelenak@fws.gov"jim_zelenak@fws.gov

You are invited to join a meeting hosted by Jodi Bush. Meeting details are listed below.

Meeting Date: 10/18/2016

Meeting Time: 1:00 PM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: 446939152

Meeting Passcode:

Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:

http://www.mymeetings.com/nc/join.php?sigKey=mymeetings&i=446939152&p=&t=c

2. Enter the required fields.

3. Indicate that you have read the Privacy Policy.

4. Click on Proceed.

From: Phifer, Paul
To: Jodi Bush
Subject: Re: Invitation: Lynx SSA Briefing @ Tue Oct 18, 2016 3pm - 4pm (paul_phifer@fws.gov)
Date: Friday, October 14, 2016 9:45:13 AM

Jodi - does this replace this afternoon's briefing? Also, the ARDs will be in a meeting together, so probably can't join on the 18th. Paul

_____
Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Fri, Oct 14, 2016 at 11:43 AM, Jodi Bush <jodi_bush@fws.gov> wrote:

Lynx SSA Briefing **more details »**

From:
Date: Thu, Oct 13, 2016 at 10:43 AM
Subject: Invitation for Instant Net Conference
To: jim_zelenak@fws.gov

You are invited to join a meeting hosted by Jodi Bush. Meeting details are listed below.

Meeting Date: 10/18/2016
Meeting Time: 1:00 PM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

When	Tue Oct 18, 2016 3pm – 4pm Eastern Time
Where	RD conference room for RO staff call in (b) (5) CIP PC (b) (5) CIP (Noreen only (b) (5) CIP) (map)
Video call	https://plus.google.com/hangouts/_/doi.gov/noreen-walsh
Calendar	paul_phifer@fws.gov
Who	• noreen_walsh@fws.gov - organizer • stephanie_potter@fws.gov - creator • Robyn Thorson • heather_bell@fws.gov • jwcummings@usgs.gov • Justin Shoemaker • Jodi Bush • mary_parkin@fws.gov • tamara_smith@fws.gov • sarah_hall@fws.gov • Tom Melius • Wendi Weber • kurt_broderdorp@fws.gov • Seth Willey • jim_zelenak@fws.gov • paul_phifer@fws.gov • mark_mccollough@fws.gov • Michael Thabault • bryon_holt@fws.gov • ted_koch@fws.gov • theresa_rabot@fws.gov • rollie_white@fws.gov • Marjorie Nelson • Martin Miller - optional • Alisa Shull - optional • Marilet Zablan - optional

Going? **Yes** - **Maybe** - **No** more options »

Invitation from Google Calendar

You are receiving this email at the account paul_phifer@fws.gov because you are subscribed for invitations on calendar paul_phifer@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From: Bush, Jodi
To: Phifer, Paul
Subject: Re: Invitation: Lynx SSA Briefing @ Tue Oct 18, 2016 3pm - 4pm (paul_phifer@fws.gov)
Date: Friday, October 14, 2016 9:55:31 AM

---

yes, it replaces todays meeting. Sorry about the change. Noreen is going on leave for a while so we were trying to squeeze it in before we leave.

The call is just informational on where we are at etc. Similar to what we talked about on phone earlier this week. but with more detail for RDs. Alot of recap from our April meeting.

I will send you any documents we prep for it (working on those now). Feel free to give me a call if you have questions. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Fri, Oct 14, 2016 at 9:45 AM, Phifer, Paul <paul_phifer@fws.gov> wrote:

> Jodi - does this replace this afternoon's briefing? Also, the ARDs will be in a meeting together, so probably can't join on the 18th. Paul
>
> _____
> Paul Phifer, PhD
> Assistant Regional Director - Ecological Services
> Northeast Region
> Dept of the Interior
> US Fish and Wildlife Service
> 413.253.8698 work
> 413.687.4764 cell
>
> On Fri, Oct 14, 2016 at 11:43 AM, Jodi Bush <jodi_bush@fws.gov> wrote:
>
> > **Lynx SSA Briefing** **more details »**
> >
> > From:
> > Date: Thu, Oct 13, 2016 at 10:43 AM
> > Subject: Invitation for Instant Net Conference
> > To: jim_zelenak@fws.gov
> >
> > You are invited to join a meeting hosted by Jodi Bush. Meeting details are listed below.
> >
> > Meeting Date: 10/18/2016
> > Meeting Time: 1:00 PM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

1. Join the meeting now:
(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

When	Tue Oct 18, 2016 3pm – 4pm Eastern Time
Where	RD conference room for RO staff call in (b) (5) CIP PC (b) (5) CIP (Noreen only (b) (5) C P (b) (5) C P 635) (map)
Video call	https://plus.google.com/hangouts/_/doi.gov/noreen-walsh
Calendar	paul_phifer@fws.gov
Who	• noreen_walsh@fws.gov - organizer • stephanie_potter@fws.gov - creator • Robyn Thorson • heather_bell@fws.gov • jwcummings@usgs.gov • Justin Shoemaker • Jodi Bush • mary_parkin@fws.gov • tamara_smith@fws.gov • sarah_hall@fws.gov • Tom Melius • Wendi Weber • kurt_broderdorp@fws.gov • Seth Willey • jim_zelenak@fws.gov • paul_phifer@fws.gov • mark_mccollough@fws.gov • Michael Thabault • bryon_holt@fws.gov • ted_koch@fws.gov

- theresa_rabot@fws.gov
- rollie_white@fws.gov
- Marjorie Nelson
- Martin Miller - optional
- Alisa Shull - optional
- Marilet Zablan - optional

Going? **Yes** - **Maybe** - **No** more options »

Invitation from Google Calendar

You are receiving this email at the account paul_phifer@fws.gov because you are subscribed for invitations on calendar paul_phifer@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From: Phifer, Paul
To: Bush, Jodi
Subject: Re: Invitation: Lynx SSA Briefing @ Tue Oct 18, 2016 3pm - 4pm (paul_phifer@fws.gov)
Date: Friday, October 14, 2016 11:08:35 AM

Thanks Jodi. I'd love to see whatever materials you have. Paul

Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Fri, Oct 14, 2016 at 12:25 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Lynx mgmt team occurs every month on first Tues. 10-11 MTN. Immediately following State call the previous week. These calls do get cancelled on occasion (couple of times this summer) if there is nothing to report. Not sure if you normally call in on that or Martin does. With your supervision change over there things might have gotten dropped too. JB
>
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
>
> On Fri, Oct 14, 2016 at 9:58 AM, Paul Phifer <paul_phifer@fws.gov> wrote:
>
> > Thanks. I'm not sure if Wendi or Deb can participate, but we will have someone. Did I miss a call this week?
> >
> > Sent from my iPhone
> >
> > On Oct 14, 2016, at 11:55 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > yes, it replaces todays meeting. Sorry about the change. Noreen is going on leave for a while so we were trying to squeeze it in before we leave.
> >
> > The call is just informational on where we are at etc. Similar to what we talked about on phone earlier this week. but with more detail for RDs. Alot of recap from our April meeting.
> >
> > I will send you any documents we prep for it (working on those now). Feel free to give me a call if you have questions. JB
> >
> > Jodi L. Bush

Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Fri, Oct 14, 2016 at 9:45 AM, Phifer, Paul <paul_phifer@fws.gov> wrote:

> Jodi - does this replace this afternoon's briefing? Also, the ARDs will be in a meeting together, so probably can't join on the 18th. Paul
>
> _____
> Paul Phifer, PhD
> Assistant Regional Director - Ecological Services
> Northeast Region
> Dept of the Interior
> US Fish and Wildlife Service
> 413.253.8698 work
> 413.687.4764 cell
>
> On Fri, Oct 14, 2016 at 11:43 AM, Jodi Bush <jodi_bush@fws.gov> wrote:
>
> > **Lynx SSA Briefing** **more details »**
> >
> > From:
> > Date: Thu, Oct 13, 2016 at 10:43 AM
> > Subject: Invitation for Instant Net Conference
> > To: jim_zelenak@fws.gov
> >
> > You are invited to join a meeting hosted by Jodi Bush. Meeting details are listed below.
> >
> > Meeting Date: 10/18/2016
> > Meeting Time: 1:00 PM MOUNTAIN TIME
> >
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> > ---
> > Meeting Number: (b) (5) CIP
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> > Join Instructions for Instant Net Conference:
> >
> > 1. Join the meeting now:
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> > (b) (5) CIP
> > 2. Enter the required fields.

3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

When	Tue Oct 18, 2016 3pm – 4pm Eastern Time
Where	RD conference room for RO staff call in 1-866-613-9547 PC 92085018 (Noreen only 51705635) (map)
Video call	https://plus.google.com/hangouts/_/doi.gov/noreen-walsh
Calendar	paul_phifer@fws.gov
Who	• noreen_walsh@fws.gov - organizer • stephanie_potter@fws.gov - creator • Robyn Thorson • heather_bell@fws.gov • jwcummings@usgs.gov • Justin Shoemaker • Jodi Bush • mary_parkin@fws.gov • tamara_smith@fws.gov • sarah_hall@fws.gov • Tom Melius • Wendi Weber • kurt_broderdorp@fws.gov • Seth Willey • jim_zelenak@fws.gov • paul_phifer@fws.gov • mark_mccollough@fws.gov • Michael Thabault • bryon_holt@fws.gov • ted_koch@fws.gov • theresa_rabot@fws.gov • rollie_white@fws.gov • Marjorie Nelson • Martin Miller - optional • Alisa Shull - optional • Marilet Zablan - optional

Going? **Yes** - **Maybe** - **No** more options »

Invitation from Google Calendar

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change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From: Phifer, Paul
To: Bush, Jodi
Subject: Re: Invitation: Lynx SSA Briefing @ Tue Oct 18, 2016 3pm - 4pm (paul_phifer@fws.gov)
Date: Friday, October 14, 2016 11:08:35 AM

Thanks Jodi. I'd love to see whatever materials you have. Paul

Paul Phifer, PhD
Assistant Regional Director - Ecological Services
Northeast Region
Dept of the Interior
US Fish and Wildlife Service
413.253.8698 work
413.687.4764 cell

On Fri, Oct 14, 2016 at 12:25 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Lynx mgmt team occurs every month on first Tues. 10-11 MTN. Immediately following State call the previous week. These calls do get cancelled on occasion (couple of times this summer) if there is nothing to report. Not sure if you normally call in on that or Martin does. With your supervision change over there things might have gotten dropped too. JB
>
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
>
> On Fri, Oct 14, 2016 at 9:58 AM, Paul Phifer <paul_phifer@fws.gov> wrote:
>
> > Thanks. I'm not sure if Wendi or Deb can participate, but we will have someone. Did I miss a call this week?
> >
> > Sent from my iPhone
> >
> > On Oct 14, 2016, at 11:55 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > yes, it replaces todays meeting. Sorry about the change. Noreen is going on leave for a while so we were trying to squeeze it in before we leave.
> >
> > The call is just informational on where we are at etc. Similar to what we talked about on phone earlier this week. but with more detail for RDs. Alot of recap from our April meeting.
> >
> > I will send you any documents we prep for it (working on those now). Feel free to give me a call if you have questions. JB
> >
> > Jodi L. Bush

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> > Join Instructions for Instant Net Conference:
> >
> > 1. Join the meeting now:
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From: Phifer, Paul
To: Jodi Bush
Subject: Re: Invitation: Lynx SSA Briefing @ Tue Oct 18, 2016 3pm - 4pm (paul_phifer@fws.gov)
Date: Friday, October 14, 2016 9:45:13 AM

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_____
Paul Phifer, PhD
Assistant Regional Director - Ecological Services
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From:	Bush, Jodi
To:	Noreen Walsh; Wendi Weber; Tom Melius; Theresa Rabot
Cc:	Thabault, Michael; Nicole Alt; Marjorie Nelson; Willey, Seth; Justin Shoemaker; Paul Phifer; Martin Miller; Mark McCollough; rollie_white@fws.gov; Sarah Hall; Bryon Holt; Kurt Broderdorp; Jim Zelenak; Bell, Heather; Cc: Mary Parkin; Tamara Smith; Marilet Zablan; Brady McGee; Lori Nordstrom; Ted Koch; Patricia Zenone
Subject:	October 18, 2016 Lynx SSA Status Update via Webinar
Date:	Monday, October 17, 2016 6:39:08 PM
Attachments:	20161018_RD Briefing Lynx SSA Status Update.docx

Just a reminder that we are having a conference call and webinar tomorrow, October 18 at 1PM MTN to give folks an update on the Lynx SSA. We will also have a short webinar. We will talk to you then. JB

Call in (b) (5) CIP PC (b) (5) CIP

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(406) 449-5225, ext.205

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Cc:	Thabault, Michael; Nicole Alt; Marjorie Nelson; Willey, Seth; Justin Shoemaker; Paul Phifer; Martin Miller; Mark McCollough; rollie_white@fws.gov; Sarah Hall; Bryon Holt; Kurt Broderdorp; Jim Zelenak; Bell, Heather; Cc: Mary Parkin; Tamara Smith; Marilet Zablan; Brady McGee; Lori Nordstrom; Ted Koch; Patricia Zenone
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INFORMATION/ BRIEFING MEMORANDUM FOR THE REGIONAL DIRECTOR

DATE: October 18, 2016

FROM: Jodi Bush, Supervisor, Montana Ecological Services Office, (406) 449-5225.

SUBJECT: Status of Lynx SSA Process for RD Briefing

We have completed a DRAFT Species Status Assessment (SSA) report for the contiguous U.S. distinct population segment (DPS) of the Canada lynx (Figure 1). The SSA was undertaken as part of the new recovery planning process. Additionally it is going to inform our response to a court order to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]"). The SSA assembles the best available information on the current status and likely future viability of the DPS. It is intended to inform multiple Service needs including a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the Endangered Species Act (Act) and (2) a recovery plan is needed to guide conservation and recovery of the DPS. It may also identify potential recovery criterion (as informed by the subsequent decision meeting) and those actions needed to achieve recovery. A status recommendation will be documented in a five-year status review based on the final SSA report.

BACKGROUND

The Service designated the lynx DPS as threatened in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands. In 2003, in response to a court ruling, we reaffirmed the DPS's status as threatened. We completed a recovery outline in 2005, designated critical habitat for the DPS in 2006, and, in 2007, again in response to a court order, clarified our determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS. We revised the critical habitat designation in 2009 and again in 2014 in response to a court order. We reinitiated the 5-year status review in January, 2015 and commenced the SSA in April, 2015. In September 2016, the court remanded the 2014 critical habitat rule for further evaluation of Colorado and five national forests in Idaho and Montana.

KEY POINTS

- We announced the re-initiation of a five-year status review on January 13, 2015. Shortly thereafter, we embarked on the SSA framework. Information in the SSA will be used by Service decision makers to inform classification decisions, recovery planning direction, and other determinations required by the Act.
- Through the SSA framework we have assessed the species' needs, current and future condition including viability of the DPS using a compilation of the best available scientific and commercial data, including empirical data, published literature, and expert input.
- We engaged State, Tribal and other Federal, and Canadian partners and other stakeholders, as well as Service managers. We coordinated with State partners and internal Service managers through separate monthly coordination calls.
- In the fall of 2015, we convened a workshop for scientific experts to address the current and likely future status of the DPS. The participants included state agencies, biologists from other federal agencies, and academic researchers to elicit input from experts across the range of the DPS.

- Information solicited from the 10 member lynx expert panel addressed the viability of the DPS based on the 3Rs (Representation, Redundancy, Resiliency) and what is known about climate science related to lynx. The resultant workshop report is one component of the SSA.
- We just completed the DRAFT SSA report and have forwarded it for internal review to Service staff in each region with lynx (Regions 1, 2, 3, 5, and 6). This review will be expedited and will focus on the science. Once completed and revisions made, the SSA will be provided to our Peer Review consultant and to State and Federal partners for their review and comment.
- Using the Service's open peer review contract, we hired ATKINS to conduct a Peer Review for us on the scientific findings in SSA. That contract is let and will commence as soon as the Service has completed our internal review.

TIMELINE

- Expert Workshop FINAL Report — April, 2016
- SSA Report
  - DRAFT Completed — October 14, 2016
  - Internal Review Complete — October 24, 2016
  - Peer/Partner Reviews Complete — December 31, 2016
  - FINAL Report Complete — January 15, 2017
- Decision Meeting — January 30, 2017
- Five-year Review
  - DRAFT — February 07, 2017
  - FINAL — February 28, 2017
- Recovery Plan
  - DRAFT using REV process (if necessary) — May 2017??
  - FINAL (if necessary) — January 2018

IMPORTANT MESSAGES

- Several decision points were agreed to in April 2016 regarding the SSA.
  - Because the climate change science is important in our decision, we asked if we needed better information to address likely impacts to lynx from CC? *Based on the additional timeline needed to gather that information, ARDs determined no.*
  - Because the decision makers will need the information on a range of climate change scenarios for their decision, we asked if they were comfortable with the range of climate scenario years from the panel report? Present, mid-century (2050), and end of century (2100*)? ARDs indicated they were.*
  - Because our partners have a strong interest in this process, we asked if when conducting Peer review of SSA, whether we wanted our State counterparts to receive it at the same time? *Based on discussions with ARDs, we will provide State counterparts with an opportunity to review the SSA during the PEER review.*
  - Finally, because the SSA is a science document not a decision document we asked if the managers wanted a recommendation from the SSA team? *The ARDs agreed that the five-year review would be the place for a recommendation from the team.*
- We are behind in the development of the recovery planning process by 6 to 9 months.

Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (Lynx canadensis) that currently support or recently supported (GYA) resident lynx populations.



From: Zelenak, Jim
To: Jodi Bush
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 2:08:53 PM

Bryon on same topic - maybe include him on reminder that this was for RDs, ARDs, and End. species leads plus SSA Team?

---------- Forwarded message ----------
From: **Holt, Bryon** <bryon_holt@fws.gov>
Date: Tue, Oct 18, 2016 at 1:58 PM
Subject: Re: October 18, 2016 Lynx SSA Status Update via Webinar
To: Jim Zelenak <jim_zelenak@fws.gov>
Cc: Gregory Hughes <greg_m_hughes@fws.gov>, Kim Garner <kim_garner@fws.gov>

Jim,

Could you add Greg Hughes to the "To" list and Kim Garner the the "cc" list for these type of calls/emails.

Thanks,

Bryon

On Mon, Oct 17, 2016 at 3:38 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Just a reminder that we are having a conference call and webinar tomorrow, October 18 at 1PM MTN to give folks an update on the Lynx SSA. We will also have a short webinar. We will talk to you then. JB
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> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
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> (406) 449-5225, ext.205

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****
Bryon Holt
U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: McCollough, Mark
To: Peter Lamothe; Smith, Glenn; Mary Parkin; Martin Miller
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 8:16:02 AM
Attachments: 20161018_RD Briefing Lynx SSA Status Update.docx

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Peter and Glenn: You are certainly welcome to participate in the webinar at 3:00 this afternoon on the lynx SSA. (See details below.) I'm not sure who else may participate from R5 as I believe Paul is away and Marty is in PA. Glenn may be on the call? Mary probably will be also.

We have completed the draft SSA and it has been distributed for in-house review. There is a relatively quick turnaround for our review before it is distributed to states and peer reviewers.

The lynx core team authors have been instructed to review the document one more time as we experienced some problems at the end with Google Drive. I will have my review completed by Friday and will forward my track changes to both of you (and Marty). Marty said that Paul would like to see our R5 comments before we respond to R6.

Thanks, Mark

---------- Forwarded message ----------
From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Mon, Oct 17, 2016 at 6:38 PM
Subject: October 18, 2016 Lynx SSA Status Update via Webinar
To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
Cc: "Thabault, Michael" <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Marjorie Nelson <Marjorie_Nelson@fws.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Martin Miller <martin_miller@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, "rollie_white@fws.gov" <rollie_white@fws.gov>, Sarah Hall <Sarah_Hall@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, "Bell, Heather" <heather_bell@fws.gov>, "Cc: Mary Parkin" <mary_parkin@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Brady McGee <Brady_McGee@fws.gov>, Lori Nordstrom <lori_nordstrom@fws.gov>, Ted Koch <ted_koch@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>

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(406) 449-5225, ext.205

--

PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED!!!!
On Tuesdays and Thursdays call 207 944-5709

Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

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Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (Lynx canadensis) that currently support or recently supported (GYA) resident lynx populations.



Gifford, Krishna <krishna_gifford@fws.gov>

Fwd: October 18, 2016 Lynx SSA Status Update via Webinar

1 message

Gifford, Krishna <krishna_gifford@fws.gov> Tue, Oct 18, 2016 at 8:53 AM
To: "Lynch, Diane" <diane_lynch@fws.gov>

---------- Forwarded message ----------
From: **Smith, Glenn** <glenn_s_smith@fws.gov>
Date: Tue, Oct 18, 2016 at 8:44 AM
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
To: Krishna Gifford <krishna_gifford@fws.gov>

FYI
---------- Forwarded message ----------
From: **McCollough, Mark** <mark_mccollough@fws.gov>
Date: Tue, Oct 18, 2016 at 8:16 AM
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
To: Peter Lamothe <peter_lamothe@fws.gov>, "Smith, Glenn" <glenn_s_smith@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Martin Miller <martin_miller@fws.gov>

Peter and Glenn: You are certainly welcome to participate in the webinar at 3:00 this afternoon on the lynx SSA. (See details below.) I'm not sure who else may participate from R5 as I believe Paul is away and Marty is in PA. Glenn may be on the call? Mary probably will be also.

We have completed the draft SSA and it has been distributed for in-house review. There is a relatively quick turnaround for our review before it is distributed to states and peer reviewers.

The lynx core team authors have been instructed to review the document one more time as we experienced some problems at the end with Google Drive. I will have my review completed by Friday and will forward my track changes to both of you (and Marty). Marty said that Paul would like to see our R5 comments before we respond to R6.

Thanks, Mark

---------- Forwarded message ----------
From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Mon, Oct 17, 2016 at 6:38 PM
Subject: October 18, 2016 Lynx SSA Status Update via Webinar
To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
Cc: "Thabault, Michael" <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Marjorie Nelson <Marjorie_Nelson@fws.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Martin Miller <martin_miller@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, "rollie_white@fws.gov" <rollie_white@fws.gov>, Sarah Hall <Sarah_Hall@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, "Bell, Heather" <heather_bell@fws.gov>, "Cc: Mary Parkin" <mary_parkin@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Brady McGee <Brady_McGee@fws.gov>, Lori Nordstrom <lori_nordstrom@fws.gov>, Ted Koch <ted_koch@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>

Just a reminder that we are having a conference call and webinar tomorrow, October 18 at 1PM MTN to give folks an update on the Lynx SSA. We will also have a short webinar. We will talk to you then. JB

Call in (b) (5) CIP PC (b) (5) CIP

Meeting Date: 10/18/2016
Meeting Time: 1:00 PM MOUNTAIN TIME
Instant Net Conference Details:

Meeting Number (b) (5) CIP
Meeting Passcode:

Meeting Host: BRENT ESMOIL
Join Instructions for Instant Net Conference:
1. Join the meeting now:
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2. Enter the required fields.
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4. Click on Proceed.

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED!!!! On Tuesdays and Thursdays call 207 944-5709

Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
Glenn S. Smith

300 Westgate Center Dr.
Hadley, MA 01035
413-253-8627

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20161018_RD Briefing Lynx SSA Status Update.docx
256K

INFORMATION/ BRIEFING MEMORANDUM FOR THE REGIONAL DIRECTOR

DATE: October 18, 2016

FROM: Jodi Bush, Supervisor, Montana Ecological Services Office, (406) 449-5225.

SUBJECT: Status of Lynx SSA Process for RD Briefing

We have completed a DRAFT Species Status Assessment (SSA) report for the contiguous U.S. distinct population segment (DPS) of the Canada lynx (Figure 1). The SSA was undertaken as part of the new recovery planning process. Additionally it is going to inform our response to a court order to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]"). The SSA assembles the best available information on the current status and likely future viability of the DPS. It is intended to inform multiple Service needs including a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the Endangered Species Act (Act) and (2) a recovery plan is needed to guide conservation and recovery of the DPS. It may also identify potential recovery criterion (as informed by the subsequent decision meeting) and those actions needed to achieve recovery. A status recommendation will be documented in a five-year status review based on the final SSA report.

BACKGROUND

The Service designated the lynx DPS as threatened in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands. In 2003, in response to a court ruling, we reaffirmed the DPS's status as threatened. We completed a recovery outline in 2005, designated critical habitat for the DPS in 2006, and, in 2007, again in response to a court order, clarified our determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS. We revised the critical habitat designation in 2009 and again in 2014 in response to a court order. We reinitiated the 5-year status review in January, 2015 and commenced the SSA in April, 2015. In September 2016, the court remanded the 2014 critical habitat rule for further evaluation of Colorado and five national forests in Idaho and Montana.

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From: Holt, Bryon
To: Kim Garner
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 11:36:01 AM
Attachments: 20161018_RD Briefing Lynx SSA Status Update.docx

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FYI

---------- Forwarded message ----------
From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Mon, Oct 17, 2016 at 3:38 PM
Subject: October 18, 2016 Lynx SSA Status Update via Webinar
To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
Cc: "Thabault, Michael" <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Marjorie Nelson <Marjorie_Nelson@fws.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Martin Miller <martin_miller@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, "rollie_white@fws.gov" <rollie_white@fws.gov>, Sarah Hall <Sarah_Hall@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, "Bell, Heather" <heather_bell@fws.gov>, "Cc: Mary Parkin" <mary_parkin@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Brady McGee <Brady_McGee@fws.gov>, Lori Nordstrom <lori_nordstrom@fws.gov>, Ted Koch <ted_koch@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>

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****
Bryon Holt
U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

From: Bush, Jodi
To: Kathleen Hendricks
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 12:05:02 PM
Attachments: 20161018_RD Briefing Lynx SSA Status Update.docx

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To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
Cc: "Thabault, Michael" <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Marjorie Nelson <Marjorie_Nelson@fws.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Martin Miller <martin_miller@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, "rollie_white@fws.gov" <rollie_white@fws.gov>, Sarah Hall <Sarah_Hall@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, "Bell, Heather" <heather_bell@fws.gov>, "Cc: Mary Parkin" <mary_parkin@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Brady McGee <Brady_McGee@fws.gov>, Lori Nordstrom <lori_nordstrom@fws.gov>, Ted Koch <ted_koch@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>

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Meeting Date: 10/18/2016 Meeting Time: 1:00 PM MOUNTAIN TIME Instant Net Conference Details: ---------- Meeting Number: 446939152 Meeting Passcode: Meeting Host: BRENT ESMOIL Join Instructions for Instant Net Conference: 1. Join the meeting now: http://www.mymeetings.com/nc/join.php?sigKey=mymeetings&i=446939152&p=&t=c 2. Enter the required fields. 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.

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From: Zenone, Patricia
To: Bush, Jodi
Subject: Re: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 1:06:59 PM

Hi Jodi,

Thank you for sending all of this information. Unfortunately, I have a mandatory office-wide meeting at 1:00 pm today and cannot be on your call. If there are webinar materials that you could send me, I would very much appreciate receiving a copy for review.

Thank you!

Best regards,
Patricia

Patricia G. Zenone, Ph.D.
Senior Fish and Wildlife Biologist
New Mexico Ecological Services Field Office
U.S. Fish and Wildlife Service
2105 Osuna, N.E.
Albuquerque, New Mexico 87113
Email: patricia_zenone@fws.gov
Phone: (505) 761-4718; Fax: (505) 346-2542

On Mon, Oct 17, 2016 at 4:38 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Just a reminder that we are having a conference call and webinar tomorrow, October 18 at 1PM MTN to give folks an update on the Lynx SSA. We will also have a short webinar. We will talk to you then. JB
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>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
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> (406) 449-5225, ext.205

From: Hendricks, Kathleen
To: Bush, Jodi
Subject: Re: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 1:58:01 PM

---

yes would have been good but I had another commitment, hopefully Bryon Holt was on the call?

Kathleen G. Hendricks
Assistant State Supervisor
1387 South Vinnell Way
Boise, Idaho 83709
208-378-5742 work
208-866-7467 cell

On Tue, Oct 18, 2016 at 12:05 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

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> Jodi L. Bush
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> Subject: October 18, 2016 Lynx SSA Status Update via Webinar
> To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
> Cc: "Thabault, Michael" <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Marjorie Nelson <Marjorie_Nelson@fws.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Martin Miller <martin_miller@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, "rollie_white@fws.gov" <rollie_white@fws.gov>, Sarah Hall <Sarah_Hall@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, "Bell, Heather" <heather_bell@fws.gov>, "Cc: Mary Parkin" <mary_parkin@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Brady McGee <Brady_McGee@fws.gov>, Lori Nordstrom <lori_nordstrom@fws.gov>, Ted Koch <ted_koch@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>
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(406) 449-5225, ext.205

From: Bush, Jodi
To: Hendricks, Kathleen
Subject: Re: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 2:08:33 PM

---

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On Tue, Oct 18, 2016 at 1:57 PM, Hendricks, Kathleen <kathleen_hendricks@fws.gov> wrote:

> yes would have been good but I had another commitment, hopefully Bryon Holt was on the call?
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> Kathleen G. Hendricks
> Assistant State Supervisor
> 1387 South Vinnell Way
> Boise, Idaho 83709
> 208-378-5742 work
> 208-866-7467 cell
>
> On Tue, Oct 18, 2016 at 12:05 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
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> > ---------- Forwarded message ----------
> > From: **Bush, Jodi** <jodi_bush@fws.gov>
> > Date: Mon, Oct 17, 2016 at 4:38 PM
> > Subject: October 18, 2016 Lynx SSA Status Update via Webinar
> > To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
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From: Holt, Bryon
To: Zelenak, Jim
Subject: Re: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 2:50:03 PM

OK. Thanks Jim. Just doing what I was asked.

On Tue, Oct 18, 2016 at 1:15 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> I forwarded to Jodi. She will send out the PDF of the presentation to folks shortly, but I believe she originally intended to only invite RDs, ARDs, Regional ESA chiefs, and the Core and FIT Teams to this call/webinar today. We will continue to have the all-FWS monthly coordination calls on first Tuesdays monthly. I'm sure Kim is on that list, and I will make sure Greg is also.
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> Thanks for your input on the call today.
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> On Tue, Oct 18, 2016 at 1:58 PM, Holt, Bryon <bryon_holt@fws.gov> wrote:
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> > Jim,
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> > Could you add Greg Hughes to the "To" list and Kim Garner the the "cc" list for these type of calls/emails.
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email: bryon_holt@fws.gov

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From: Zelenak, Jim
To: Holt, Bryon
Subject: Re: October 18, 2016 Lynx SSA Status Update via Webinar
Date: Tuesday, October 18, 2016 3:03:54 PM

No worries, Bryon.

We will probably do a similar presentation/webinar on the next all-FWS coordination call - Tues., Nov 1, and notice of that will go out to all the ROs and FOs in the range.

Jodi and I also discussed bumping the State coordination call from next Wed. to the following Wed. (Nov.2), and giving a similar webinar for that update. I will send that out later this week also.

We will also have our weekly Core/FIT call next Tues. at 10 Mountain Time. I'll send out reminder for that later this week.

Thanks again for joining today.

On Tue, Oct 18, 2016 at 2:50 PM, Holt, Bryon <bryon_holt@fws.gov> wrote:

> OK. Thanks Jim. Just doing what I was asked.
>
> On Tue, Oct 18, 2016 at 1:15 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
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From:	Bush, Jodi
To:	Noreen Walsh; Wendi Weber; Tom Melius; Theresa Rabot
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Subject:	PPT for Regional Director Briefing on Lynx SSA Status Update via Webinar
Date:	Tuesday, October 18, 2016 4:25:37 PM
Attachments:	2016 10 18 R6RD Update Lynx SSA_FINAL.pdf

As requested, here is the pdf of the webinar presentation Jim gave today. If you have questions please feel free to give Jim (406-449-5225, x220) or I a call. Thanks. JB

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Update on Canada Lynx Species Status Assessment

October 18, 2016

Overview

- What are we doing?
  - Completing SSA to inform recovery planning
    - Court order to finalize RP by Jan. 2018
    - Unless we determine RP not needed (i.e., the DPS is recovered)
- Why?
  - SSA provides analysis needed to re-evaluate the status of the DPS
  - SSA will then be used in decision context of 5-year review (before proceeding with recovery planning)

Objectives

- Share Status of the SSA
- Discuss Timeline
- Identify Next Steps

Lynx Basics

- Boreal forest species dependent on snowshoe hares and favorable snow conditions
- At southern periphery of ranges in contiguous US
- Habitat becomes patchy; hare densities and snow conditions become suboptimal/marginal for supporting lynx populations
- Mainland-island metapopulation structure (?)
- Historical cyclic "irruptions" of lynx from Canada into northern U.S. when hares crashed (currently?)

Background

- Contiguous U.S. lynx DPS listed as T in 2000
  - Factor D - inadequacy, at that time, of existing regulatory mechanisms on federal lands
- CH designated 2006, revised 2009 and 2014
  - Sept. 2016 - Court remanded 2014 CH rule
    - Ruled Service was arbitrary and capricious in not designating CH in Colorado
    - Inadequate evaluation of PCE on 5 NFs in MT and ID
    - We have not determined next steps in our response to this litigation

Background

- 2005 Recovery Outline focused on interim conservation measures in 6 "Core" areas
  - Historic/current resident population(s); reproduction; 0.5 hares/ha; >= 1,250 km^2 habitat
  - S. Rockies (western CO and south central WY) - "provisional" core area

Current DPS Distribution

- 6 geographic areas known or thought to support resident lynx populations in the DPS:
  - 1. Northern Maine (& northernmost NH and VT)
  - 2. Northeastern Minnesota
  - 3. Northwestern Montana/Northeastern Idaho
  - 4. North-central Washington
  - 5. GYA of southwest Montana/northwest Wyoming
  - 6. Western Colorado – introduced population

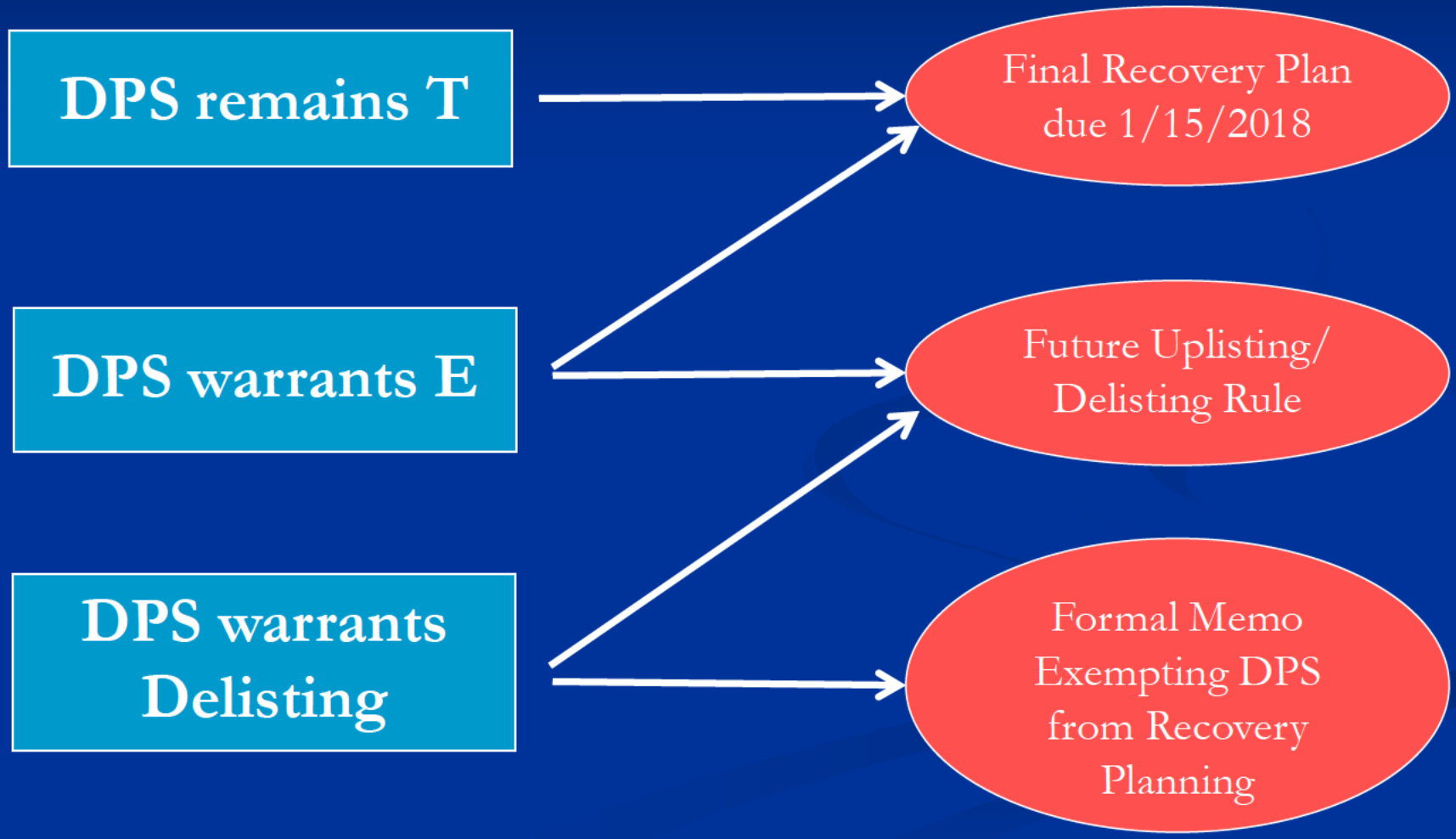


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*) that currently support or recently supported (GYA) resident lynx populations.

Key Points

- January 2015 - announced re-initiation of five-year status review
- March 2015 – determined need to complete SSA
- Information in the SSA will be used by FWS decision makers to inform:
  - Recovery planning direction
  - Classification decisions
  - Other determinations required by the ESA

Potential Findings



Key Points

- Through the SSA process we have:
  - Assessed the current status of, threats to, and future viability of the lynx DPS
  - Compiled and summarized the best available scientific and commercial data, including empirical data, published literature, and expert input
  - Prioritized information and used modeling to best evaluate potential future conditions, threats and viability

Key Points

- We continue to engage State, Tribal and other Federal, and Canadian partners and other stakeholders
- We continue to work and coordinate with other regions across DPS range
- Monthly State and internal FWS coordination calls/webinars

Expert Elicitation Workshop

- October 2015 – Lynx SSA Team (FWS & USGS) convened a workshop with lynx experts to address current and likely future status of lynx populations in the DPS
  - 10 members of expert panel included state and federal biologists and academic researchers across the range of the DPS and southern Canada
  - The resultant workshop report is one component of the SSA

Expert Elicitation Workshop

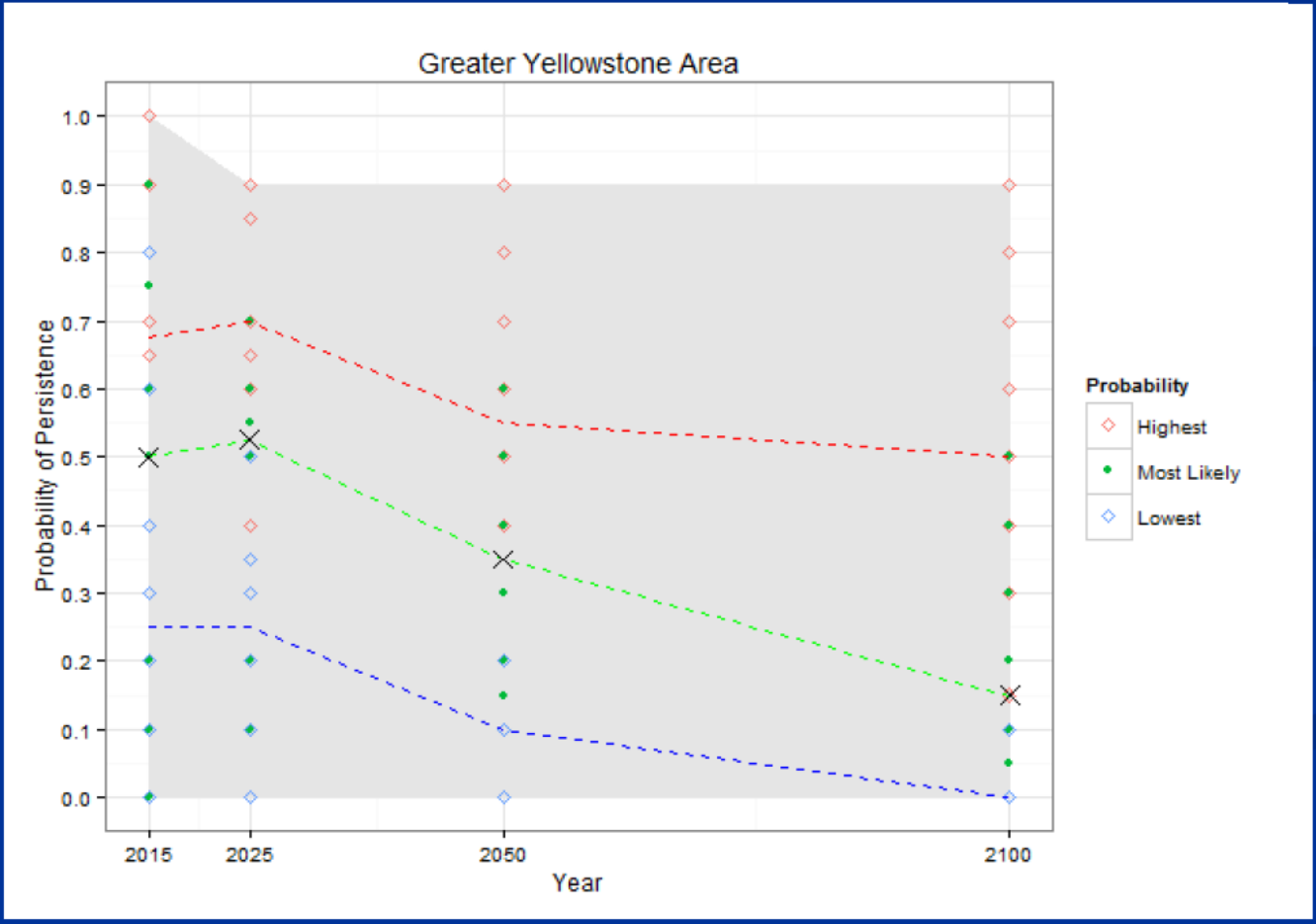
- Responses: Representation
  - Few threats to the genetic fitness or adaptive capacity of lynx in the DPS
    - High gene flow; no major barriers to dispersal
  - Adaptability and evolutionary capacity of the DPS does not appear to have been diminished and is unlikely to become so, independent of threats that may impact the redundancy and persistence of lynx populations

Expert Elicitation Workshop

- Responses: Redundancy
  - DPS as a whole is not vulnerable to extirpation from a single catastrophic event
    - No catastrophic event that could result in the functional extirpation of the entire DPS
  - No or a very low likelihood of functional extirpation of any of the individual geographic units due to a single catastrophic event

Expert Elicitation Workshop

- Responses: Resiliency – expert panel predicted persistence of lynx in each geographic unit, e.g.:

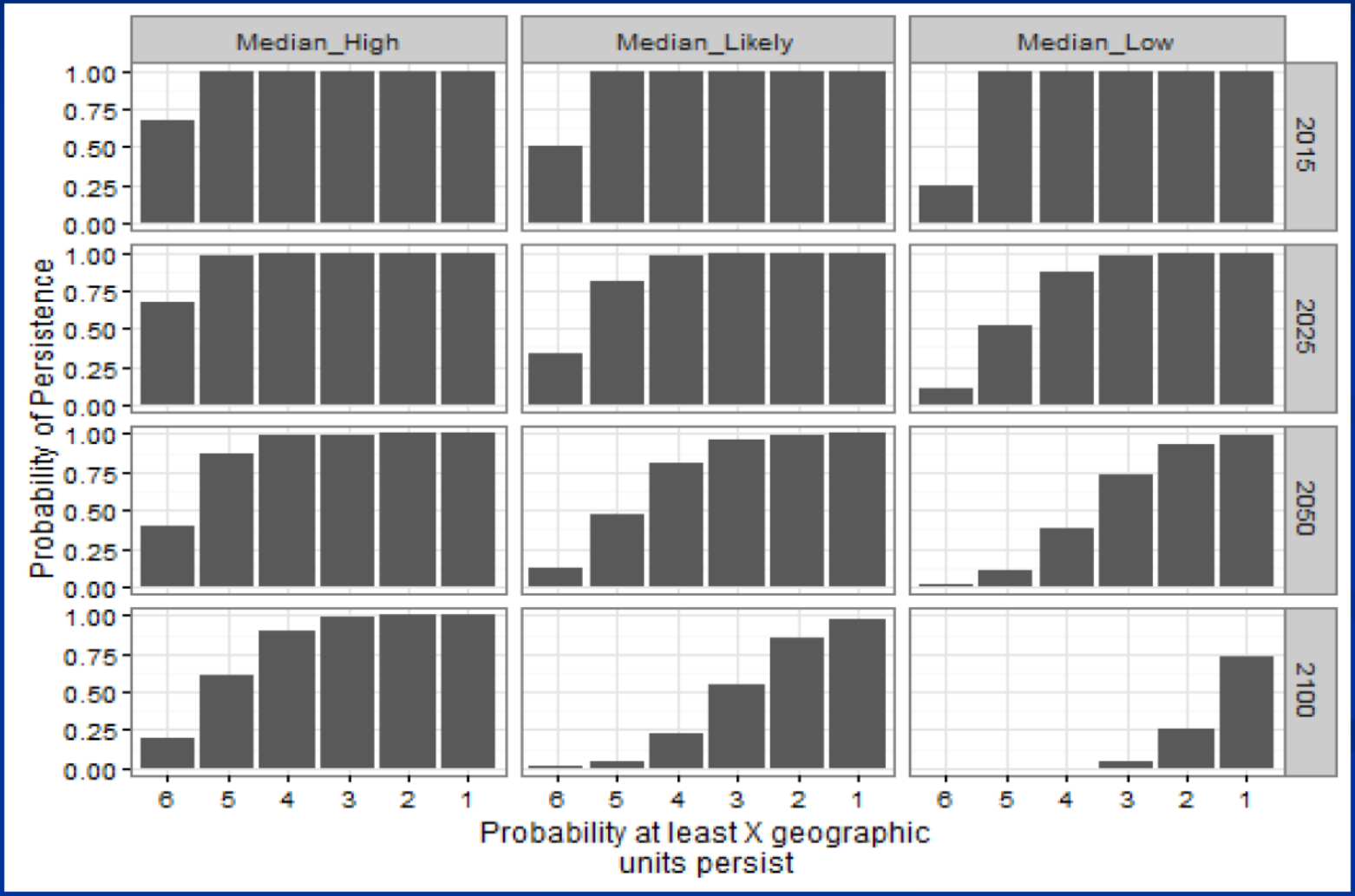


Expert Elicitation Workshop

- Responses: Resiliency
  - All 5 occupied units have >70% expectation of supporting resident lynx populations by year 2050
  - Declining likelihood and greater uncertainty by 2100 – only one unit has >50% probability of persistence
  - Responses suggest overarching threat to long-term persistence of DPS is climate change
    - Loss of snow conditions favorable for lynx
    - Subsequent (lagged) loss of boreal forest habitats
    - Timing and magnitude of such losses are uncertain

Expert Elicitation Workshop

- Overall message of the expert workshop report



Draft SSA Report

- Compiles information on historic and current DPS distribution
- Assesses needs of individuals and populations
- Describes factors with potential population-level influences on the DPS
- Evaluates current and likely future conditions of lynx populations in each geographic unit in terms of the 3 Rs
- SSA Team generally agrees with lynx experts; perhaps less optimistic about some areas

Draft SSA Report - Results

- DPS currently exhibits adequate redundancy and representation; populations in most geographic areas exhibit adequate resiliency
- Resident lynx likely to persist in most units through 2050
- Loss of residents (functional extirpation) from 2 or 3 units (of 5) by 2100; much uncertainty
- Continued climate warming is largest threat
- Regulations to conserve lynx on federal lands are now in place; effectiveness uncertain/untested
- Forest management on private lands remains a significant issue in Maine, perhaps in Minnesota

Next Steps

- DRAFT SSA Report is undergoing internal Service scientific review
- After that review and revision, a final draft SSA will be provided to Peer Reviewers through our contractor
- Concurrent with Peer Review, we will share with State, Federal and Tribal(?) partners; invite their review/ comments on the science
- All reviewers (FWS, peer reviewers, partners) will be asked to focus their comments on the science of the SSA Report (not subsequent listing determinations or recovery planning issues)

Next Steps

- Once comments and peer reviews are in, the FINAL SSA Report will be completed
- A Decision Team will meet to discuss SSA results and the DPS status review
- Based on the SSA Report and results of the Decision Team meeting, a DRAFT five year review document will be developed
- After internal review, a FINAL five year review document will be completed, wrapping up the updated status review
- Depending on the RDs decision, recovery planning will proceed from that point or not

Revised Timeline

- Expert Workshop Report — April 2016
- DRAFT SSA Report — October 14, 2016
  - Internal Review Complete — ~October 24, 2016
  - Peer & Partner Review Complete — ~December 31, 2016
- FINAL SSA Report Complete — ~January 15, 2017
- Decision Meeting — ~January 30, 2017
- Five-year Review
  - Draft — ~February 7, 2017
  - Final — ~February 28, 2017
- Draft Recovery Plan (if necessary) — MAY 2017??
- Final Recovery Plan (if necessary) — JANUARY 2018

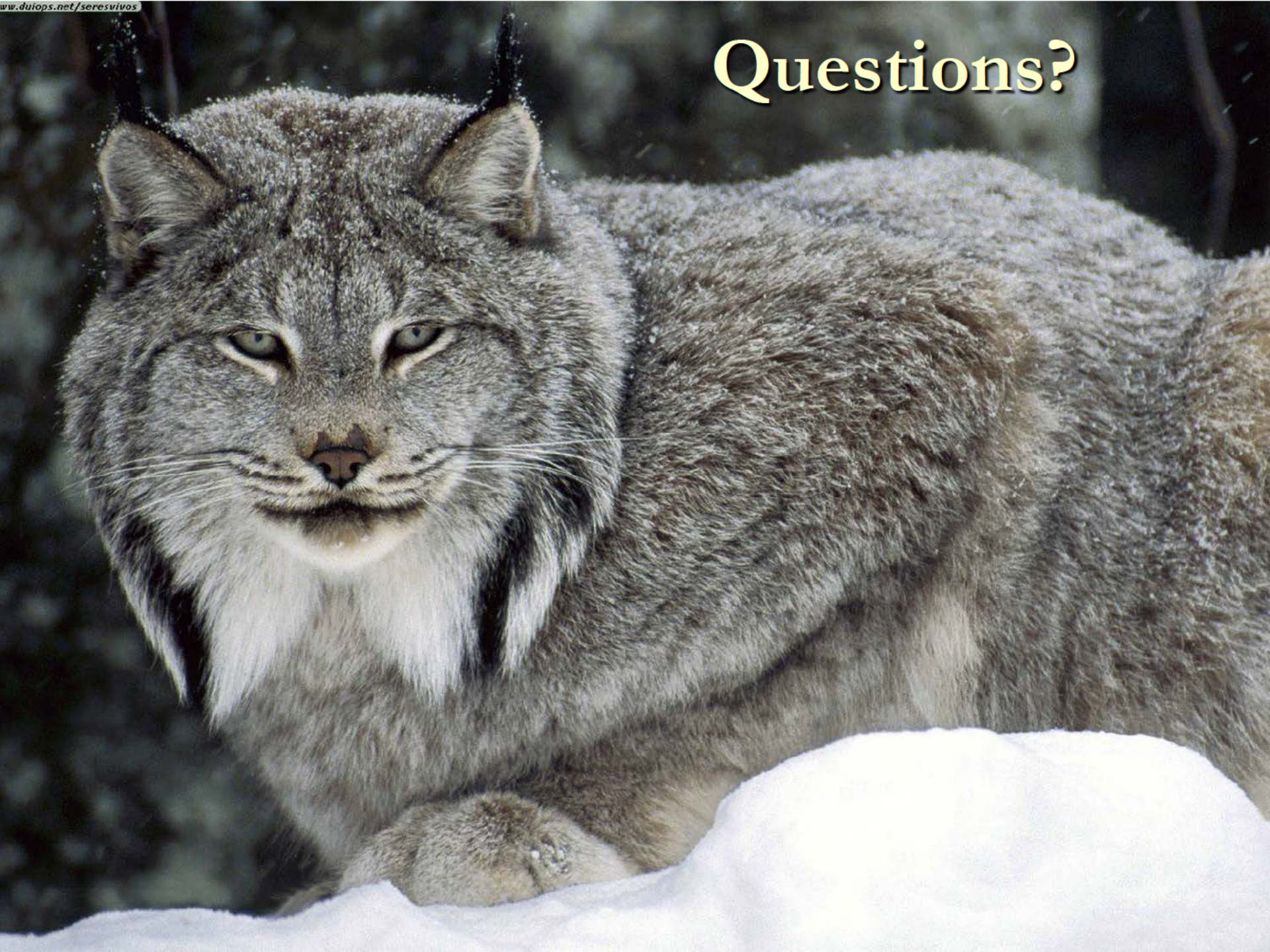
Decision Points

We asked ARDs in spring 2016:

- Do we need better information to address likely impacts to lynx from CC? Based on the additional timeline needed to gather that information, ARDs determined no.
- Are we comfortable with the time frames used to assess viability of the DPS as presented in the panel report - near term (year 2025), mid-century (2050), and end of century (2100)? ARDs indicated they were.
- When conducting peer review of SSA, do we want our State counterparts to receive it at the same time? Based on discussions with ARDs, we will provide State counterparts with an opportunity to review the SSA during the peer review.
- Do managers want any recommendation from team in the SSA? ARDs agreed that the five-year review would be the place for a recommendation from the team (after discussing with Decision Team).

Main Messages

- We are making progress but we are behind in the recovery planning process by over 9 months
- We are hopeful that the SSA process and report will facilitate a quick, streamlined, REV-compliant draft recovery plan by May 2017 so we can complete the final by Jan. 2018
- In general, the FWS Lynx SSA Team feels comfortable with the outcomes from the expert panel workshop and the DRAFT SSA Report


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Questions?

Gifford, Krishna <krishna_gifford@fws.gov>

Fwd: October 18, 2016 Lynx SSA Status Update via Webinar

1 message

Gifford, Krishna <krishna_gifford@fws.gov> Tue, Oct 18, 2016 at 8:53 AM
To: "Lynch, Diane" <diane_lynch@fws.gov>

---------- Forwarded message ----------
From: **Smith, Glenn** <glenn_s_smith@fws.gov>
Date: Tue, Oct 18, 2016 at 8:44 AM
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
To: Krishna Gifford <krishna_gifford@fws.gov>

FYI
---------- Forwarded message ----------
From: **McCollough, Mark** <mark_mccollough@fws.gov>
Date: Tue, Oct 18, 2016 at 8:16 AM
Subject: Fwd: October 18, 2016 Lynx SSA Status Update via Webinar
To: Peter Lamothe <peter_lamothe@fws.gov>, "Smith, Glenn" <glenn_s_smith@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Martin Miller <martin_miller@fws.gov>

Peter and Glenn: You are certainly welcome to participate in the webinar at 3:00 this afternoon on the lynx SSA. (See details below.) I'm not sure who else may participate from R5 as I believe Paul is away and Marty is in PA. Glenn may be on the call? Mary probably will be also.

We have completed the draft SSA and it has been distributed for in-house review. There is a relatively quick turnaround for our review before it is distributed to states and peer reviewers.

The lynx core team authors have been instructed to review the document one more time as we experienced some problems at the end with Google Drive. I will have my review completed by Friday and will forward my track changes to both of you (and Marty). Marty said that Paul would like to see our R5 comments before we respond to R6.

Thanks, Mark

---------- Forwarded message ----------
From: **Bush, Jodi** <jodi_bush@fws.gov>
Date: Mon, Oct 17, 2016 at 6:38 PM
Subject: October 18, 2016 Lynx SSA Status Update via Webinar
To: Noreen Walsh <noreen_walsh@fws.gov>, Wendi Weber <wendi_weber@fws.gov>, Tom Melius <tom_melius@fws.gov>, Theresa Rabot <theresa_rabot@fws.gov>
Cc: "Thabault, Michael" <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>, Marjorie Nelson <Marjorie_Nelson@fws.gov>, "Willey, Seth" <seth_willey@fws.gov>, Justin Shoemaker <justin_shoemaker@fws.gov>, Paul Phifer <paul_phifer@fws.gov>, Martin Miller <martin_miller@fws.gov>, Mark McCollough <Mark_McCollough@fws.gov>, "rollie_white@fws.gov" <rollie_white@fws.gov>, Sarah Hall <Sarah_Hall@fws.gov>, Bryon Holt <Bryon_Holt@fws.gov>, Kurt Broderdorp <Kurt_Broderdorp@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, "Bell, Heather" <heather_bell@fws.gov>, "Cc: Mary Parkin" <mary_parkin@fws.gov>, Tamara Smith <Tamara_Smith@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Brady McGee <Brady_McGee@fws.gov>, Lori Nordstrom <lori_nordstrom@fws.gov>, Ted Koch <ted_koch@fws.gov>, Patricia Zenone <patricia_zenone@fws.gov>

Just a reminder that we are having a conference call and webinar tomorrow, October 18 at 1PM MTN to give folks an update on the Lynx SSA. We will also have a short webinar. We will talk to you then. JB

Call in (b) (5) CIP PC (b) (5) CIP

Meeting Date: 10/18/2016
Meeting Time: 1:00 PM MOUNTAIN TIME
Instant Net Conference Details:

Meeting Number: 446939152
Meeting Passcode:

Meeting Host: BRENT ESMOIL
Join Instructions for Instant Net Conference:
1. Join the meeting now:
http://www.mymeetings.com/nc/join.php?sigKey=mymeetings&i=446939152&p=&t=c
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

--
PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED!!!! On Tuesdays and Thursdays call 207 944-5709

Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
Glenn S. Smith

300 Westgate Center Dr.
Hadley, MA 01035
413-253-8627

"The Year Of 7(a)(1)" - *"Better Conservation More Efficiently"*
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20161018_RD Briefing Lynx SSA Status Update.docx
256K

INFORMATION/ BRIEFING MEMORANDUM FOR THE REGIONAL DIRECTOR

DATE: October 18, 2016

FROM: Jodi Bush, Supervisor, Montana Ecological Services Office, (406) 449-5225.

SUBJECT: Status of Lynx SSA Process for RD Briefing

We have completed a DRAFT Species Status Assessment (SSA) report for the contiguous U.S. distinct population segment (DPS) of the Canada lynx (Figure 1). The SSA was undertaken as part of the new recovery planning process. Additionally it is going to inform our response to a court order to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]"). The SSA assembles the best available information on the current status and likely future viability of the DPS. It is intended to inform multiple Service needs including a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the Endangered Species Act (Act) and (2) a recovery plan is needed to guide conservation and recovery of the DPS. It may also identify potential recovery criterion (as informed by the subsequent decision meeting) and those actions needed to achieve recovery. A status recommendation will be documented in a five-year status review based on the final SSA report.

BACKGROUND

The Service designated the lynx DPS as threatened in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands. In 2003, in response to a court ruling, we reaffirmed the DPS's status as threatened. We completed a recovery outline in 2005, designated critical habitat for the DPS in 2006, and, in 2007, again in response to a court order, clarified our determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS. We revised the critical habitat designation in 2009 and again in 2014 in response to a court order. We reinitiated the 5-year status review in January, 2015 and commenced the SSA in April, 2015. In September 2016, the court remanded the 2014 critical habitat rule for further evaluation of Colorado and five national forests in Idaho and Montana.

KEY POINTS

- We announced the re-initiation of a five-year status review on January 13, 2015. Shortly thereafter, we embarked on the SSA framework. Information in the SSA will be used by Service decision makers to inform classification decisions, recovery planning direction, and other determinations required by the Act.
- Through the SSA framework we have assessed the species' needs, current and future condition including viability of the DPS using a compilation of the best available scientific and commercial data, including empirical data, published literature, and expert input.
- We engaged State, Tribal and other Federal, and Canadian partners and other stakeholders, as well as Service managers. We coordinated with State partners and internal Service managers through separate monthly coordination calls.
- In the fall of 2015, we convened a workshop for scientific experts to address the current and likely future status of the DPS. The participants included state agencies, biologists from other federal agencies, and academic researchers to elicit input from experts across the range of the DPS.

- Information solicited from the 10 member lynx expert panel addressed the viability of the DPS based on the 3Rs (Representation, Redundancy, Resiliency) and what is known about climate science related to lynx. The resultant workshop report is one component of the SSA.
- We just completed the DRAFT SSA report and have forwarded it for internal review to Service staff in each region with lynx (Regions 1, 2, 3, 5, and 6). This review will be expedited and will focus on the science. Once completed and revisions made, the SSA will be provided to our Peer Review consultant and to State and Federal partners for their review and comment.
- Using the Service's open peer review contract, we hired ATKINS to conduct a Peer Review for us on the scientific findings in SSA. That contract is let and will commence as soon as the Service has completed our internal review.

TIMELINE

• Expert Workshop FINAL Report	April, 2016
• SSA Report	
o DRAFT Completed	October 14, 2016
o Internal Review Complete	October 24, 2016
o Peer/Partner Reviews Complete	December 31, 2016
o FINAL Report Complete	January 15, 2017
• Decision Meeting	January 30, 2017
• Five-year Review	
o DRAFT	February 07, 2017
o FINAL	February 28, 2017
• Recovery Plan	
o DRAFT using REV process (if necessary)	May 2017??
o FINAL (if necessary)	January 2018

IMPORTANT MESSAGES

- Several decision points were agreed to in April 2016 regarding the SSA.
  - Because the climate change science is important in our decision, we asked if we needed better information to address likely impacts to lynx from CC? *Based on the additional timeline needed to gather that information, ARDs determined no.*
  - Because the decision makers will need the information on a range of climate change scenarios for their decision, we asked if they were comfortable with the range of climate scenario years from the panel report? Present, mid-century (2050), and end of century (2100*)? ARDs indicated they were.*
  - Because our partners have a strong interest in this process, we asked if when conducting Peer review of SSA, whether we wanted our State counterparts to receive it at the same time? *Based on discussions with ARDs, we will provide State counterparts with an opportunity to review the SSA during the PEER review.*
  - Finally, because the SSA is a science document not a decision document we asked if the managers wanted a recommendation from the SSA team? *The ARDs agreed that the five-year review would be the place for a recommendation from the team.*

- We are behind in the development of the recovery planning process by 6 to 9 months.

Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (Lynx canadensis) that currently support or recently supported (GYA) resident lynx populations.



From:	Zelenak, Jim
To:	Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Anthony Tur; Brad Thompson; Chris Mensing; David Stilwell; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Karl Halupka; Kate Novak; Kim Garner; Larry Crist; Laura Ragan; Leslie Ellwood; Mark Maghini; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tyler Abbott; Wally Murphy; Dennis Mackey; Patricia Zenone; Gary Miller; Karen Cathey; Steve Spangle; Tom McDowell
Subject:	Fwd: Invitation for Instant Net Conference
Date:	Tuesday, November 01, 2016 10:17:16 AM

Hi All:

We will have the monthly internal FWS Lynx SSA coordination call and a webinar update this morning at 10:00 AM Mountain Time.

(b) (5) CIP
Passcode: (b) (5) CIP

Webinar link/info provided below.

Thanks,

Jim

---------- Forwarded message ----------
From: <e-meetings@mymeetings.com>
Date: Tue, Nov 1, 2016 at 8:10 AM
Subject: Invitation for Instant Net Conference
To: jim_zelenak@fws.gov

You are invited to join a meeting hosted by Jim Zelenak. Meeting details are listed below.

Meeting Date: 11/01/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Kosterman, Megan
Subject: Re: Invitation for Instant Net Conference
Date: Tuesday, November 01, 2016 4:12:35 PM
Attachments: 2016 11 01 Internal FWS Update Lynx SSA.pdf

Thanks Megan.

Hope a PDF works (Boss's recommendation).

Hope all is well.

On Tue, Nov 1, 2016 at 11:40 AM, Kosterman, Megan <megan_kosterman@fws.gov> wrote:

> Hi Jim,
>
> Great job today! Could you email me a copy of your Powerpoint?
>
> On Tue, Nov 1, 2016 at 7:17 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi All:
> >
> > We will have the monthly internal FWS Lynx SSA coordination call and a webinar update this morning at 10:00 AM Mountain Time.
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> > Meeting Host: BRENT ESMOIL

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Endangered Species Biologist
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jim_zelenak@fws.gov

Update on Canada Lynx Species Status Assessment

November 1, 2016

Overview

- What are we doing?
  - Completing SSA to inform recovery planning
    - Court order to finalize RP by Jan. 2018
    - Unless we determine RP not needed (i.e., the DPS is recovered)
- Why?
  - SSA provides analysis needed to re-evaluate the status of the DPS
  - SSA will then be used in decision context of 5-year review (before proceeding with recovery planning)

Objectives

- Share Status of the SSA
- Discuss Timeline
- Identify Next Steps

Lynx Basics

- Boreal forest species dependent on snowshoe hares and favorable snow conditions
- At southern periphery of ranges in contiguous US
- Habitat becomes patchy; hare densities and snow conditions become suboptimal/marginal for supporting lynx populations
- Mainland-island metapopulation structure (?)
- Historical cyclic "irruptions" of lynx from Canada into northern U.S. when hares crashed (currently?)

Background

- Contiguous U.S. lynx DPS listed as T in 2000
  - Factor D - inadequacy, at that time, of existing regulatory mechanisms on federal lands
- CH designated 2006, revised 2009 and 2014
  - Sept. 2016 - Court remanded 2014 CH rule
    - Ruled Service was arbitrary and capricious in not designating CH in Colorado
    - Inadequate evaluation of PCE on 5 NFs in MT and ID
    - We have not determined next steps in our response to this litigation

Background

- 2005 Recovery Outline focused on interim conservation measures in 6 "Core" areas
  - Historic/current resident population(s); reproduction; 0.5 hares/ha; >= 1,250 km^2 habitat
  - S. Rockies (western CO and south central WY) - "provisional" core area

Current DPS Distribution

- 6 geographic areas known or thought to support resident lynx populations in the DPS:
  - 1. Northern Maine (& northernmost NH and VT)
  - 2. Northeastern Minnesota
  - 3. Northwestern Montana/Northeastern Idaho
  - 4. North-central Washington
  - 5. GYA of southwest Montana/northwest Wyoming
  - 6. Western Colorado – introduced population

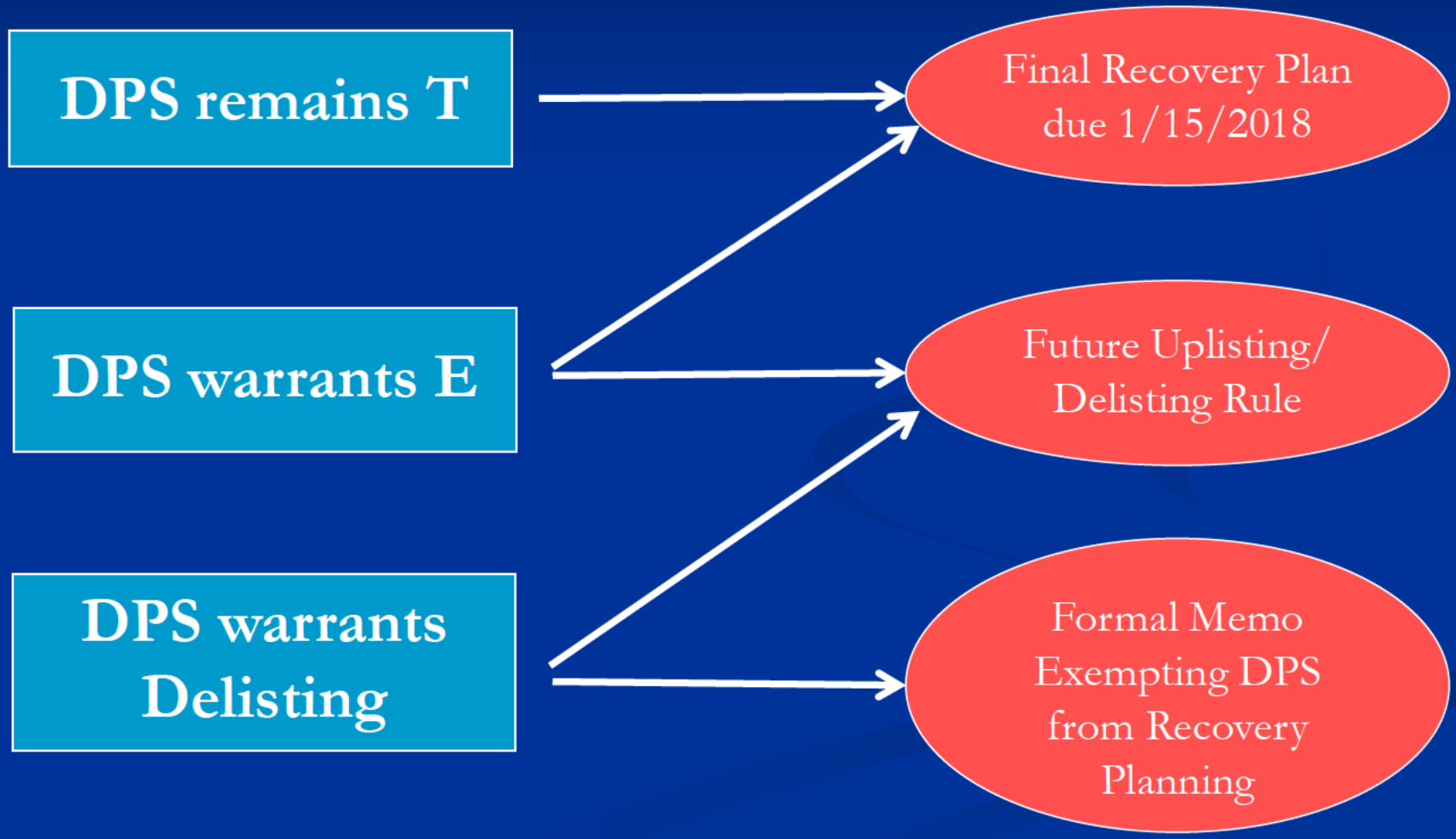


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*) that currently support or recently supported (GYA) resident lynx populations.

Key Points

- January 2015 - announced re-initiation of five-year status review
- March 2015 – determined need to complete SSA
- Information in the SSA will be used by FWS decision makers to inform:
  - Recovery planning direction
  - Classification decisions
  - Other determinations required by the ESA

Potential Findings



Key Points

- Through the SSA process we have:
  - Assessed the current status of, threats to, and future viability of the lynx DPS
  - Compiled and summarized the best available scientific and commercial data, including empirical data, published literature, and expert input
  - Prioritized information and used modeling to best evaluate potential future conditions, threats and viability

Key Points

- We continue to engage State, Tribal and other Federal, and Canadian partners and other stakeholders
- We continue to work and coordinate with other regions across DPS range
- Monthly State and internal FWS coordination calls/webinars

Expert Elicitation Workshop

- October 2015 – Lynx SSA Team (FWS & USGS) convened a workshop with lynx experts to address current and likely future status of lynx populations in the DPS
  - 10 members of expert panel included state and federal biologists and academic researchers across the range of the DPS and southern Canada
  - The resultant workshop report is one component of the SSA

Expert Elicitation Workshop

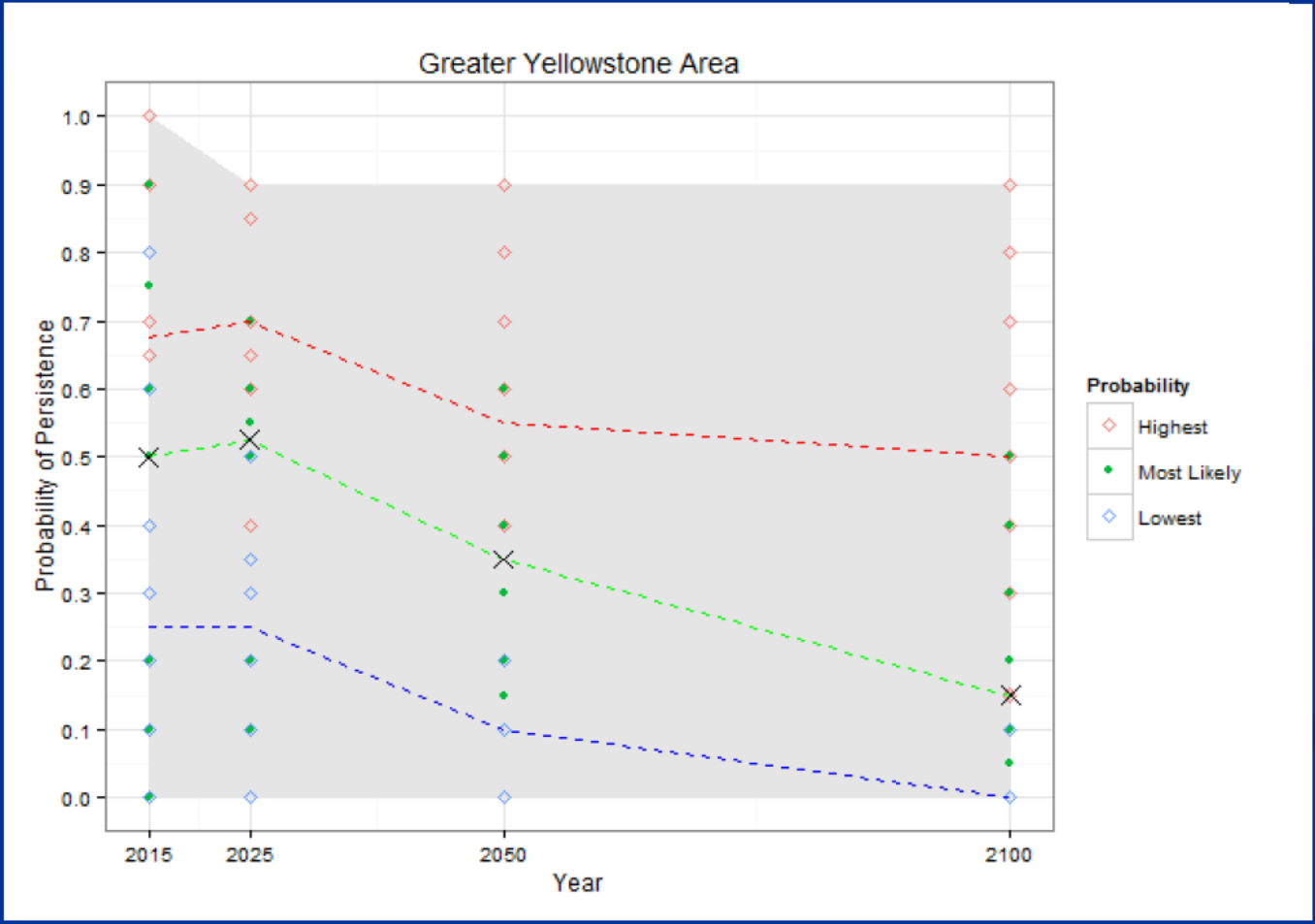
- Responses: Representation
  - Few threats to the genetic fitness or adaptive capacity of lynx in the DPS
    - High gene flow; no major barriers to dispersal
  - Adaptability and evolutionary capacity of the DPS does not appear to have been diminished and is unlikely to become so, independent of threats that may impact the redundancy and persistence of lynx populations

Expert Elicitation Workshop

- Responses: Redundancy
  - DPS as a whole is not vulnerable to extirpation from a single catastrophic event
    - No catastrophic event that could result in the functional extirpation of the entire DPS
  - No or a very low likelihood of functional extirpation of any of the individual geographic units due to a single catastrophic event

Expert Elicitation Workshop

- Responses: Resiliency – expert panel predicted persistence of lynx in each geographic unit, e.g.:

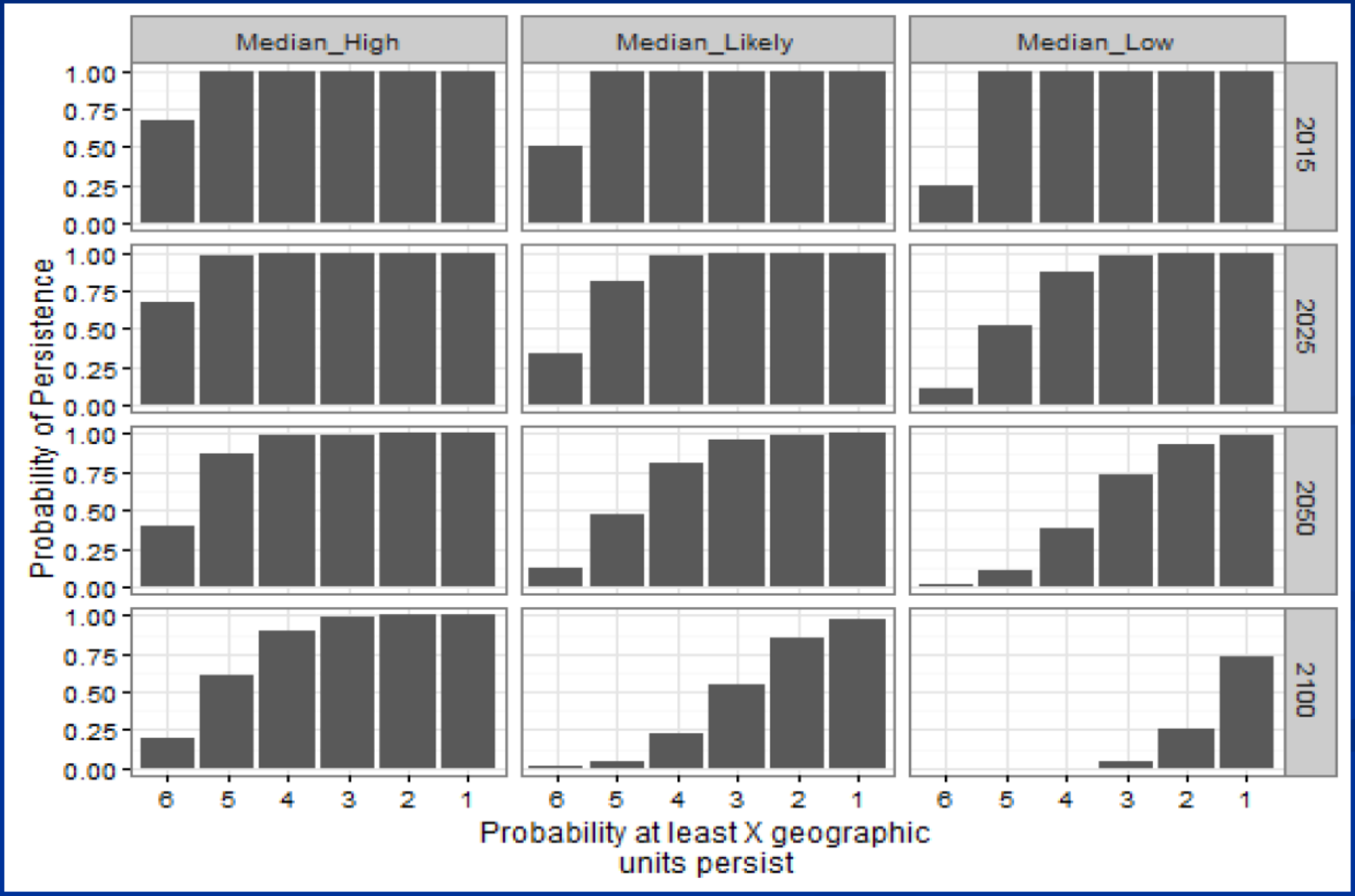


Expert Elicitation Workshop

- Responses: Resiliency
  - All 5 occupied units have >70% expectation of supporting resident lynx populations by year 2050
  - Declining likelihood and greater uncertainty by 2100 – only one unit has >50% probability of persistence
  - Responses suggest overarching threat to long-term persistence of DPS is climate change
    - Loss of snow conditions favorable for lynx
    - Subsequent (lagged) loss of boreal forest habitats
    - Timing and magnitude of such losses are uncertain

Expert Elicitation Workshop

- Overall message of the expert workshop report



Draft SSA Report

- Compiles information on historic and current DPS distribution
- Assesses needs of individuals and populations
- Describes factors with potential population-level influences on the DPS
- Evaluates current and likely future conditions of lynx populations in each geographic unit in terms of the 3 Rs
- SSA Team generally agrees with lynx experts; perhaps less optimistic about some areas

Draft SSA Report - Results

- DPS currently exhibits adequate redundancy and representation; populations in most geographic areas exhibit adequate resiliency
- Resident lynx likely to persist in most units through 2050
- Loss of residents (functional extirpation) from 2 or 3 units (of 5) by 2100; much uncertainty
- Continued climate warming is largest threat
- Regulations to conserve lynx on federal lands are now in place; effectiveness uncertain/untested
- Forest management on private lands remains a significant issue in Maine, perhaps in Minnesota

Next Steps

- DRAFT SSA Report is undergoing internal Service scientific review
- After that review and revision, a final draft SSA will be provided to Peer Reviewers through our contractor
- Concurrent with Peer Review, we will share with State, Federal and Tribal partners; invite their review/ comments on the science
- All reviewers (FWS, peer reviewers, partners) will be asked to focus their comments on the science of the SSA Report (not subsequent listing determinations or recovery planning issues)

Next Steps

- Once comments and peer reviews are in, the FINAL SSA Report will be completed
- A Decision Team will meet to discuss SSA results and the DPS status review
- Based on the SSA Report and results of the Decision Team meeting, a DRAFT five year review document will be developed
- After internal review, a FINAL five year review document will be completed, wrapping up the updated status review
- Depending on the RDs decision, recovery planning will proceed from that point or not

Revised Timeline

- Expert Workshop Report — April 2016
- DRAFT SSA Report — October 14, 2016
  - Internal Review Complete — ~October 24, 2016
  - Peer & Partner Review Complete — ~December 31, 2016
- FINAL SSA Report Complete — ~January 15, 2017
- Decision Meeting — ~January 30, 2017
- Five-year Review
  - Draft — ~February 7, 2017
  - Final — ~February 28, 2017
- Draft Recovery Plan (if necessary) — MAY 2017??
- Final Recovery Plan (if necessary) — JANUARY 2018

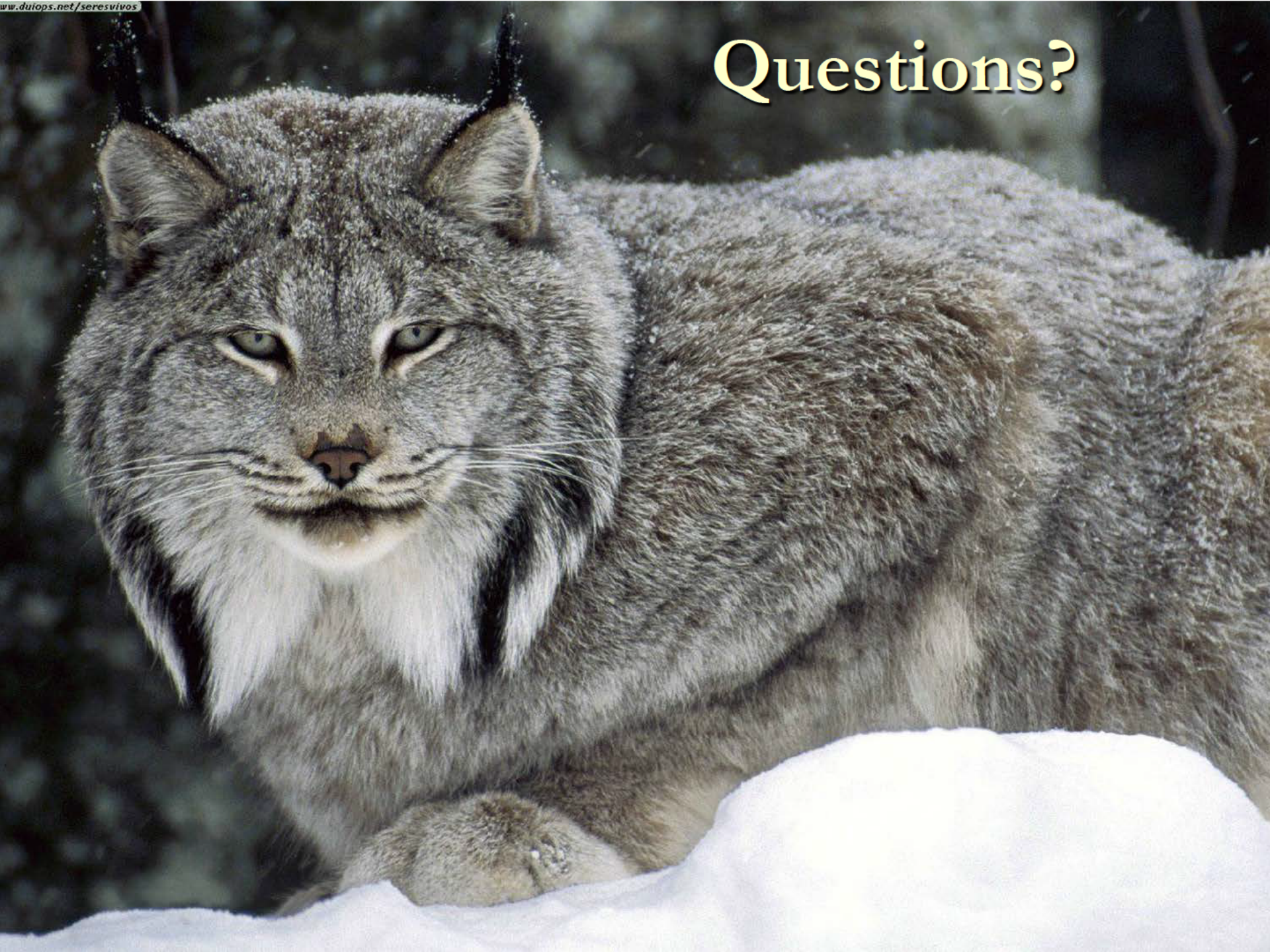
Decision Points

We asked ARDs in spring 2016:

- Do we need better information to address likely impacts to lynx from CC? Based on the additional timeline needed to gather that information, ARDs determined no.
- Are we comfortable with the time frames used to assess viability of the DPS as presented in the panel report - near term (year 2025), mid-century (2050), and end of century (2100)? ARDs indicated they were.
- When conducting peer review of SSA, do we want our State counterparts to receive it at the same time? Based on discussions with ARDs, we will provide State counterparts with an opportunity to review the SSA during the peer review.
- Do managers want any recommendation from team in the SSA? ARDs agreed that the five-year review would be the place for a recommendation from the team (after discussing with Decision Team).

Main Messages

- We are making progress but we are behind in the recovery planning process by over 9 months
- We are hopeful that the SSA process and report will facilitate a quick, streamlined, REV-compliant draft recovery plan by May 2017 so we can complete the final by Jan. 2018
- In general, the FWS Lynx SSA Team feels comfortable with the outcomes from the expert panel workshop and the DRAFT SSA Report


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Questions?

From: Zelenak, Jim
To: Kosterman, Megan
Subject: Re: Invitation for Instant Net Conference
Date: Wednesday, November 02, 2016 8:35:53 AM

Of course - share internally. The one today for States/partners will be largely the same; only a few slides (internal FWS deliberations/discussions) omitted.

On Tue, Nov 1, 2016 at 4:25 PM, Kosterman, Megan <megan_kosterman@fws.gov> wrote:

> Thanks Jim! A PDF is great. May I share the PDF with Bryon Holt, and Kim Garner/Kathleen Hendricks from our Boise office (USFWS employees only)? They all wanted to participate in the meeting today but were unable to attend. If you prefer I don't share the PDF, that is fine also, I will just send them my meeting notes.
>
> On Tue, Nov 1, 2016 at 3:12 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
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> > Thanks Megan.
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> > > >
> > > > Webinar link/info provided below.
> > > >
> > > > Thanks,
> > > >
> > > > Jim
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> > > > ---------- Forwarded message ----------
> > > > From: <e-meetings@mymeetings.com>
> > > > Date: Tue, Nov 1, 2016 at 8:10 AM
> > > > Subject: Invitation for Instant Net Conference
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below.

Meeting Date: 11/01/2016
Meeting Time: 10:00 AM MOUNTAIN TIME

Instant Net Conference Details:

Meeting Number: (b) (5) CIP
Meeting Passcode:
Meeting Host: BRENT ESMOIL

Join Instructions for Instant Net Conference:

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(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
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From:	Anna Harris
To:	McCollough, Mark
Subject:	Re: Updated Invitation: Lynx core team/FIT call, 10-11 MST @ Tue Nov 22, 2016 12pm - 1pm (mark_mccollough@fws.gov)
Date:	Tuesday, November 22, 2016 11:45:46 AM

I will try to make this call,

Thanks for sending Mark

Sent from my iPhone

On Nov 22, 2016, at 11:33 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Anna:
>
> I'm sorry this is very short notice, but you are welcome to call in to our lynx SSA call at noon today (in 30 minutes). It would give you a sense of what we are working on in the final stages of writing the SSA. Call-in information is below. Otherwise, we have a monthly internal call for USFWS when most project leaders and RO staff call in to track our progress. I believe the next one of these calls is next week.
>
> Mark
> ---------- Forwarded message ----------
> From: **Mary Parkin** <mary_parkin@fws.gov>
> Date: Tue, Nov 15, 2016 at 2:55 PM
> Subject: Updated Invitation: Lynx core team/FIT call, 10-11 MST @ Tue Nov 22, 2016 12pm - 1pm (mark_mccollough@fws.gov)
> To: mark_mccollough@fws.gov, tamara_smith@fws.gov, heather_bell@fws.gov, jim_zelenak@fws.gov, bryon_holt@fws.gov, jodi_bush@fws.gov, jwcummings@usgs.gov, marjorie_nelson@fws.gov, kurt_broderdorp@fws.gov
>
> **This event has been changed.**
>
> **Lynx core team/FIT call, 10-11 MST** **more details »**
>
> **Changed:** Update on SSA report/assignments, timeline, and decision phase (5-yr status recommendation). Jim will lead!
>
> When Tue Nov 22, 2016 12pm – 1pm Eastern Time
>
> Where (b) (5) CIP , passcode (b) (5) CIP (map)
>
> Calendar mark_mccollough@fws.gov
>
> Who
> - mary_parkin@fws.gov - organizer
> - tamara_smith@fws.gov
> - heather_bell@fws.gov
> - jim_zelenak@fws.gov
> - bryon_holt@fws.gov

- jodi_bush@fws.gov
- jwcummings@usgs.gov
- marjorie_nelson@fws.gov
- kurt_broderdorp@fws.gov
- mark_mccollough@fws.gov

Going? **Yes** - **Maybe** - **No** more options »

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mark_mccollough@fws.gov

<invite.ics>

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<invite.ics>

From:	Zelenak, Jim
To:	Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Jodi Bush
Subject:	Fwd: Lynx SSA comments
Date:	Monday, November 28, 2016 1:33:37 PM
Attachments:	2016 10 14 DRAFT Lynx SSA Report CLEAN_MJMcomments.docx

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Please see Mark's and Marty's comments below (and Marty's detailed comments in the attached doc). We need to discuss this on the weekly Core/FIT teams call tomorrow and agree to an appropriate and efficient way to respond in the next draft of the SSA Report.

I hope you all can join the call.

10 AM Mountain Time
(b) (5) CIP
Participant passcode: (b) (5) CIP

---------- Forwarded message ----------
From: **McCollough, Mark** <mark_mccollough@fws.gov>
Date: Tue, Nov 22, 2016 at 11:19 AM
Subject: Fwd: Lynx SSA comments
To: Tamara Smith <tamara_smith@fws.gov>, Jim Zelenak <jim_zelenak@fws.gov>, Mary Parkin <mary_parkin@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>, Bryon Holt <bryon_holt@fws.gov>

Lynx Core Team:

I'm not sure if you all received a copy of Marty Miller's comments from Region 5. Jim said that they are also posted on the Google Drive. Here is a copy of Marty's comments. Given our marching orders from today's call, I would recommend that you look at Marty's comments, especially for Chapter 5. I think it will help you to understand the kind of clarification he is asking for to address points #1 and #2 in his email below.

Jim, maybe you can take a look at how each of the Core Team members address Marty's points #1 and #2 and address Marty's point #3 - our ultimate, collective conclusion. This conclusion ties into today's discussion about listing (without addressing listing in the SSA). Marty seems to indicate we can walk a fine line between making OUR assessment of lynx persistence, assumptions, and uncertainty without addressing listing in the SSA (see point #3).

It's still unclear to me whether the Core Team will formally or informally be asked for our opinion on listing and when this might happen. Up to now, we've been instructed not to discuss listing in the context of the SSA. But as we move very soon into the decision phase, maybe the Core Team should discuss our individual and collective thoughts about listing. Perhaps after we address Marty's points below, we will be in a better position to do so.

This all would be far better done on a napkin in the pub in Denver.

Have a good Thanksgiving.

Mark

---------- Forwarded message ----------
From: **Miller, Martin** <martin_miller@fws.gov>
Date: Mon, Oct 31, 2016 at 12:21 PM
Subject: Lynx SSA comments
To: Mark McCollough <Mark_McCollough@fws.gov>
Cc: Mary Parkin <mary_parkin@fws.gov>

Mark - Here are my comments on the lynx SSA. I focused on the Future Conditions and Synthesis chapters. I have three major comments:

1. Establishing the proper context for the future: This is a future with lynx not being listed. The document presents a delisting scenario in its evaluation of the Federal management future of the MT/ID Unit. I explain in my comments that, while the conclusions about what the future will look like may be OK, the way we get there needs to be revised. And this context needs to be established for evaluation across all units, actors (Federal agencies, states, landowners, etc.), and consequences (not just regulatory mechanisms).

2. Explaining how the experts' opinions inform our conclusions: The document does not explain what we think about the experts' opinions (agree or disagree and why). I was expecting this explanation for each unit in Chapter 5 in the "Service Evaluation" section, which follows the "Expert Projections,' but these two discussion appear to be independent. We continue to refer to the experts' opinions about persistence to the very end without ever saying whether we agree with them (and explaining why).

3. Drawing meaningful conclusions: The ultimate conclusions we make (the DPS has a decreasing probability of persistence into the future) is meaningless as it can be said of every species on earth. I recommend we present "our" conclusions on persistence. If we thought it was valuable to know what the experts think about persistence, we need to at least present our conclusions on persistence. I understand we are advised not to present our conclusions in a manner that too closely resembles a conclusion about listing being warranted or not. But we're too far down the "probability of persistence" road to avoid presenting our conclusions on this. And we need to do it in a way that describes the magnitude of the risk, not statements that are generalized to the point of being meaningless.

Many of the comments I made on the Executive Summary I did not bother repeating in the Chapters.

Let me know if you have any questions.
Marty

--
Martin Miller, Chief, Division of Endangered Species, Northeast Region, U.S. Fish and Wildlife Service, 300 Westgate Center Drive, Hadley, MA 01035, 413-253-8615

--
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Species Status Assessment

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment



Photo by Keith Williams

Version 2.0 - Draft
~~September~~ October 2016

U.S. Fish and Wildlife Service
Regions 1, 3, 5 and 6

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    - 5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho
    - 5.2.4 Unit 4 - North-central Washington
    - 5.2.5 Unit 5 - Greater Yellowstone Area
    - 5.2.6 Unit 6 - Western Colorado

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Chapter 6: Synthesis

Executive Summary

Background

This report presents the results of a species status assessment (SSA) conducted for the contiguous United States distinct population segment (DPS) of Canada lynx (*Lynx canadensis*). The DPS was listed in 2000 as threatened under the Endangered Species Act (ESA) because of the inadequacy of regulatory mechanisms on federal lands. The SSA will provide the scientific basis for the statutorily required 5-year status review for this listed species and other decisions the Service is required to make in accordance with the ESA. The SSA provides an evaluation of the current and future status of lynx in six geographic units within the DPS that currently support or recently supported resident breeding populations. The units are distributed across the northern contiguous U.S. from Maine to Washington and south along the Rocky Mountains to western Colorado. These geographic units combined represent approximately the southern two percent of the species' entire breeding range (ninety-eight percent occurs in Canada and Alaska). The units are relatively isolated from each other, although four of the six units are directly connected to lynx populations and habitats in Canada. These SSA geographic units are:

Unit No.	Name	Size (km^2)
Unit 1	Northern Maine	28,909
Unit 2	Northeastern Minnesota	21,101
Unit 3	Northwestern Montana/Northeastern Idaho	26,997
Unit 4	North-central Washington	5,176
Unit 5	Greater Yellowstone Area	23,687
Unit 6	Western Colorado	25,294

The SSA relied on both the available scientific literature and the professional judgments and opinions of recognized lynx experts to (1) describe the ecological requirements and population dynamics of the species, (2) evaluate the historical and current status of lynx populations in the six geographic units and the factors that appear to have influenced these populations, and (3) assess the likely future viability of the DPS through the end of the century in terms of representation, redundancy, and resiliency (the "3 Rs").

Lynx are habitat and prey specialists and require boreal forests having long winters with deep, fluffy snow. These conditions provide lynx with a competitive advantage over other predators for exploiting their primary prey, the snowshoe hare. Lynx habitat and, thus, lynx are naturally less abundant and more patchily distributed in the DPS than in the core of the species' range in Canada and Alaska. This is because the DPS occurs at the southernmost margin of the

Comment [MJM1]: This comes across too much as "deferring" to expert opinion. We need to "own" the conclusions. We need to make it clear hat "our" assessment was informed by the experts' opinions – that we didn't automatically accept the expert's opinions. We need to explain the reasons behind the experts' opinions, explain why we agree or disagree, and then state the conclusions as our own.

Comment [MJM2]: The document sometimes uses historic and sometimes historical. Recommend being consistent. Recommend "historical" to avoid confusion with he "momentous" meaning of "historic."

Comment [MJM3]: The purpose of the SSA should be to assess the full risk profile of the species, not just its "likely" future. The viability of the species should be a descrip ion of the risk to its persistence, which may be influenced by possible future scenarios that are less than likely.

species' range and of the environmental thresholds of snow quality, depth, and persistence; hare density; and boreal forest conditions that lynx require. Maintaining connectivity between the DPS and lynx populations in Canada is thought to be important, but whether DPS populations rely on intermittent immigration of lynx from Canada, and, if so, to what extent, remain uncertain.

Research and surveys undertaken since the listing of the DPS in 2000 have significantly improved our knowledge of the distribution, habitats, and population status of resident breeding lynx populations. For example, although we knew there were resident lynx in Maine, we did not have an understanding of population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS; we also understand that past timber management has created the current abundance of high-quality lynx habitat, and we believe that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain as to whether Minnesota supported a resident breeding population, but we now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. are naturally less abundant and more patchily distributed than was thought at the time of listing, and lynx may have been recently extirpated from several areas thought to have previously supported small resident populations (the Kettle Mountains in northeastern Washington, the Garnet Mountains in western Montana, and the Greater Yellowstone Area). We also know that recent extensive wildfires in north-central Washington have temporarily reduced the amount of high-quality lynx habitat and have probably caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999 to 2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado.

Comment [MJM4]: To dis inguish from regulatory status as E or T.

SSA Framework

The framework for conducting an SSA takes into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time. Relative to the ecological requirements of the lynx within the DPS, we assessed current conditions at the individual, population, and range-wide levels, and the likely changes in the environment that may influence the future condition of individuals, populations, and the DPS and thus the viability of the DPS.

Comment [MJM5]: The contribution to risk from less-than-likely changes to he environment also need to be assessed.

The SSA uses the conservation biology principles of representation, redundancy, and resiliency (the "3 Rs") as the framework for assessing current and future conditions. Resiliency describes the ability of the species to withstand stochasticity, redundancy describes the ability of the species to withstand catastrophic events, and representation describes the ability of the species to adapt over time to long-term changes in the environment. The 3 Rs can be influenced by any number of factors. For the lynx, these factors included the original reason for listing the lynx DPS as threatened: inadequacy of regulatory mechanisms. Other factors included climate change, vegetation management, wildfires, and habitat connectivity

SSA Assumptions and Uncertainties

A fundamental hypothesis underlying the SSA is that the ability of lynx to persist in the DPS is a function of metapopulation dynamics with Canada, i.e., the DPS is infused intermittently with lynx from Canada following high hare cycles.

Overall, uncertainties abound with regard to lynx demography and effects of various stressors on DPS populations. The primary sources of uncertainty for this analysis include a lack of empirical data regarding population sizes and trends, the extent of immigration of lynx from Canada ~~to the persistence of U. S. populations~~, trends in hare populations, and effects of habitat management on lynx. Most importantly given the importance of climate change as a stressor, we lack information on the pace and extent of changes in snow quality, depth, and persistence and how ~~this~~these changes affect~~s~~ the relationship between lynx and their competitors.

For purposes of the SSA, we forecasted potential effects and trends through the end of this century. This time frame is based on the level of uncertainty about climate change and other effects on lynx populations; it is also a long enough time frame to detect lynx population trends across the DPS.

Current Conditions

Currently, ~~four~~ of the six DPS units, four (Northern Maine, Minnesota, Northwestern Montana, and Western Colorado) demonstrate high levels of resiliency. The North-central Washington Unit (Unit 4) was also considered resilient until recent wildfires consumed an extensive amount of habitat, likely resulting in a diminished population that may be susceptible to stochastic events. The Greater Yellowstone area historically supported resident lynx, but it is unclear whether the area still supports a breeding population due to the distance and relative isolation of the unit from Canada as well as the less than favorable habitat conditions and snowshoe hare densities.

As shown in the table above, five of the six units are larger than 20,000 km^2; the other is over 5,000 km^2. Land ownership within the units varies from mostly private in Maine, to a mix of private, State, and ~~f~~Federal lands in Minnesota, to mostly ~~f~~Federal lands in the West. Overall, ~~f~~Federal lands account for nearly 64 percent of the areas encompassed by the SSA units. Of non-~~f~~Federal areas, private lands make up almost 27 percent of the total followed by State and Tribal lands. Available data indicate that distribution within the DPS remains similar to historical patterns and that the number of units across the DPS has not been meaningfully diminished from historical levels, given the uncertainty about the past occupancy of the Greater Yellowstone area by a resident breeding lynx population.

Given the resiliency of most geographic units and the ~~improbability~~ low likelihood that a~~ny imminent~~ catastrophic event will cause the extirpation of an entire unit or, especially, the DPS as a whole in the near term, redundancy is not currently a~~n~~ issue for the lynx DPS. Also, because

Comment [MJM6]: This doesn't make sense in this phrase.

Comment [MJM7]: This is inconsistently referred to as Northwestern Montana and Northwestern Montana/Northeastern Idaho. Recommend being consistent.

Comment [MJM8]: Resiliency relates to the ability to withstand stochas icity. How is it a factor in drawing this conclusion about redundancy?

Comment [MJM9]: This seems to be saying we know of at least one catastrophic event hat will happen soon but won't cause extirpation. This is at odds with our definition of a catastrophic event as an event that would or has high potential to cause extirpation. Because he kinds of catastrophic events we typically deal with are unpredictable, we can't say a catastrophic event is imminent unless it's already started. A catastrophic event has a low likelihood of occurring within a short period of ime and a higher likelihood over a longer period of time. I think what we're trying to say is simply hat a catastrophic event is not likely to happen in the near term.

Comment [MJM10]: I was confused by this wording. We're in the business of assessing risk over decades into he future, so a factor hat affects that long-term risk would be an issue for us to evaluate now and therefore would be curren ly an issue. I think what we're trying to say is that it is "not an issue for the near-term persistence of the DPS."

lynx are genetically similar throughout the entire range of the species, and because we did not find any diminishment of adaptability and evolutionary capacity of DPS populations based on the known historical record, we do not consider representation to be a current issue for lynx.

The original reason for which the DPS was listed, inadequacy of regulatory mechanisms, has been largely ameliorated on public lands within the western geographic units. Climate change, vegetation management, wildfires, and habitat fragmentation are now stressors of more heightened concern. We know that wildfires are causing depletion of lynx in some areas in the West, particularly in the North-~~C~~central Washington Unit. We also know that past vegetation management in the ~~n~~Northern Maine Unit has resulted in a lynx population that is currently the largest in the DPS. Conversely, stressors such as climate change and associated habitat alterations, while currently occurring, may not demonstrate demographic effects on lynx within the next decade.

Future Conditions

Resiliency of individual geographic units, which function independently of each other, is the primary determinant of future lynx DPS viability. Overall, our analysis indicates a ~~reduced~~decreasing probability of persistence for ~~all~~each geographic unit~~s~~ within the DPS over the rest of the century (noting that the analysis did not extend beyond that 2100 time frame). It further indicates a consequent permanent loss of two to four of the six units, i.e., loss of resiliency, by the end of the century.

Representation and redundancy are lesser factors for DPS viability~~,~~ for several reasons. Although the populations in the DPS units are demographically isolated from each other, there is little risk of significant genetic drift within the DPS, likely due to most areas being relatively well connected with Canadian populations; this is indicative of relative genetic health through the end of the century. Furthermore, based on expert input, there is no indication that the relatively low level of genetic diversity is likely to reduce DPS viability in the future (USFWS 2016, p. 51). Because of the ability of lynx to widely disperse, and because it is unlikely that insurmountable barriers to lynx dispersal between Canada and the DPS will emerge, we do not expect representation to become a concern through the turn of the century.

With regard to redundancy, neither the scientific literature nor expert input provide a basis for concluding that any catastrophic event could cause extirpation of any one geographic unit. It is even ess likey that a single catastrophic event will eliminate all populations in the DPS. It is important to note, however, that a sequence of less-than-catastrophic events could result in extirpat~~e~~ion of one or more ~~individual~~ units over time, thereby reducing redundancy within the DPS.

The likelihood of persistence of individual populations, and thus geographic units, is expected to decrease by 2100 primarily because of climate change effects on snow conditions and boreal forests. The other long-term threat is forest management practices that are not conducive to landscape hare densities able to support lynx, although this stressor may be limited to one geographic unit. Threats affecting the future condition of the DPS are summarized below.

Comment [MJM11]: See comment above.

Comment [MJM12]: By itself, this sounds like a good thing. Explain how this is a "heightened concern."

Comment [MJM13]: Is this the imeframe that defines current condition? If not, say instead something like "may not cause demographic effects for a decade or more."

Comment [MJM14]: Reduced from what?

This is a meaningless statement. Every species has a decreasing probability of persistence with increasing time. Describe the decrease in terms of its magnitude and significance.

Comment [MJM15]: Is this change correct? Or are you trying to say one or more units have increasing probabilities but the DPS as a whole has a decreasing probability?

Comment [MJM16]: Wouldn't loss of populations be a loss of redundancy, not resiliency? The loss of a population is a loss of redundancy; the means by which a population is lost is the decrease in resilience over ime that leads to the ultimate outcome of loss of the population.

Comment [MJM17]: I assume this is based on he "most likely" future scenario. What is he risk of loss of more than two to four units? We need to know the full risk profile.

Comment [MJM18]: But is there a meaningful risk?

Comment [MJM19]: But is there a meaningful risk?

Comment [MJM20]: "Could" simply means "possible" and is ambiguous. Would be better to say there is "no meaningful risk" of a catastrophic event causing extirpa ion of any one unit.

Comment [MJM21]: The odds of all of several events happening is always less than he odds of any single event happening. Describe this risk in more absolute terms rather han in terms of a meaningless comparison.

Comment [MJM22]: I read his as referring to a sequence of catastrophic events, each one causing ex irpation of a unit. Made this change to avoid that interpretation.

Comment [MJM23]: Isn't this statement saying the same hing as the last sentence in he first paragraph of this section? This sentence says the loss of popula ions "could" occur; the sentence in the first paragraph describes this as predicted to happen. Recommend being more precise.

Comment [MJM24]: This is a meaningless statement. Every species has a decreasing likelihood of persistence over time. What we're talking about here is our prediction of a decrease of a certain magnitude that is due to certain factors. Recast the sentence to something like "The predicted decrease in th...

Based on climate change models, the effects of climate change on snow and boreal forest conditions are foreseen as the primary stressor limiting future viability of lynx in the DPS. The southernmost boreal habitats are predicted to retreat northward and upslope, fragmenting and diminishing the quality of lynx and hare habitat within the DPS (although some uncertainty remains regarding the timing, extent, and biological consequences of such impacts). As habitat conditions decline, mortality rates are likely to increase and reproductive rates decrease. This in turn will reduce abundance and density of individuals within populations, making lynx populations more susceptible to stochastic events.

Given the percent of ~~f~~Federal land ownership, ~~-~~regulatory assurances that these lands will be managed in accordance with lynx conservation, and a stronger possibility that lynx populations will be able to relocate to higher elevations, western geographic units are more likely to support lynx longer than other units under projected climate change scenarios. Nonetheless, we are unaware of any management action that can abate the long-term retreat of boreal forests and changed snow conditions. Further, climate-induced frequency and intensity of wildfires and disease events ~~is~~are expected to increase, particularly in the western portion of the DPS, although we do not anticipate such events ~~in and of themselves~~ alone to cause the permanent loss of breeding lynx populations in the North~~west~~-central Washington Unit or any other unit.

With regard to the eastern geographic units (Minnesota and Maine), suitable boreal forest and snow conditions are projected to decline more severely than in the western units. Lynx habitat conditions in Maine are also likely to decline significantly by the end of the century as private forest management practices, particularly a decline in clearcutting, result in succession detrimental to snowshoe hare and lynx needs.

DPS viability

Although there is no evidence from the historical record that Canada lynx have declined within the DPS, a number of threats acting at the DPS and individual geographic unit scales indicate a moderate to high likelihood of declines (i.e., loss of two to four units) by the turn of the century. While it is more likely than not that any given individual unit—~~n~~Northern Maine, ~~n~~Northeastern Minnesota, ~~n~~Northwestern Montana, ~~w~~Western Colorado, and possibly ~~n~~North-central Washington—will persist to mid-century, t is unlikely all that five will persist to that point. By the end of the century, we expect populations to persist primarily in units having high-elevation refugia, e.g., northwestern Montana and possibly western Colorado, although Colorado would be an isolated unit. Lynx may also persist at the end of the century in Maine, depending on the severity of climate change effects and trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in concert with input from lynx experts indicates that all units will exhibit declines by 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the eventual loss of resiliency indicated by extirpation of geographic units will also reduce redundancy and, possibly, representation. These losses in resiliency, redundancy,

Comment [MJM25]: I can't tell what this is referring to. North-central Washington or Northwestern Montana.

Comment [MJM26]: This is good to know, but what I really want to know is the probability that all five will not persist to that point – i.e., the risk of ex inction.

Comment [MJM27]: But what is he risk that hey don't?

Comment [MJM28]: But what is he risk that hey will not?

and representation will put the Canada lynx U.S. DPS at increasing risk of extinction over the course of this century, and in all probability, the risk will continue to increase after that point.

Comment [MJM29]: This is a meaningless statement. All species are at increasing risk of extinction over time.

Chapter 1: Introduction

The U.S. Fish and Wildlife Service (Service) designated lynx in the contiguous U.S. as a distinct population segment (DPS) and listed it as threatened under the Endangered Species Act of 1973, as amended (ESA) in 2000 (65 FR 16052-16086). On May 8, 2014, the United States District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (U.S. District Court MT 2014b, p. 2). Thus, we conducted this SSA (version 1.0) to summarize the best available information on the current status and likely future viability of the DPS. This SSA will inform a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the ESA and (2) a recovery plan is needed to guide conservation and recovery of the lynx DPS.

1.1 Background

The Canada lynx is a North American wild cat that is most strongly associated with northern-latitude boreal forests (taiga) of Canada and Alaska (McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 373-374; Mowat *et al*. 2000, p. 272). It relies heavily on adequate populations of its primary prey, the snowshoe hare (*Lepus americanus*), to support survival, reproduction, recruitment, and, therefore, population persistence (Ruggiero *et al*. 2000a, p. 110; Mowat *et al*. 2000, p. 270; Steury and Murray 2004, pp. 128, 136-138; U.S. Fish and Wildlife Service 2005, p. 2; Interagency Lynx Biology Team [ILBT] 2013, pp. 30-34; 79 FR 54808-54809). Lynx survival and distribution is also influenced by snow conditions. It is generally restricted to areas that receive deep, powdery, and persistent snow that allows lynx, with their proportionately longer limbs and very large feet, to outcompete other terrestrial hare predators that are less efficient in such conditions (McCord and Cardoza 1982, pp. 748-749; Quinn and Parker 1987, p. 684; Buskirk *et al*. 2000a, pp. 89-94; Buskirk *et al*. 2000b, pp. 400-401; Ruggiero *et al*. 2000b, pp. 445–449; Hoving 2001, p. 75; Hoving *et al*. 2005, p. 744-749; Carroll 2007, entire; Gonzalez *et al*. 2007, entire; ILBT 2013, pp. 25-26; 79 FR 54809).

Lynx are generally considered secure, widespread, abundant, and distributed throughout most of their historic ranges in Canada and Alaska, which, combined, account for roughly 98 percent of the species' distribution. Lynx are distributed across approximately 5.5 million km^2 (2.1 million mi^2) in Canada (Environment Canada 2014, p. 2) and 534,454 km^2 (206,354 mi^2) in Alaska (University of Alaska Center for Science Conservation 2016, entire; Reimer 2016, pers. comm.). The southern peripheries of the boreal forest and the distributions of snowshoe hares and lynx extend into the northern contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 379-382; Hodges 2000, pp. 163-173; McKelvey *et al*. 2000a, pp. 242-253), where the six geographic units evaluated in this

SSA represent the remaining 2 percent of the species' breeding distribution (approximately 131,168 km^2 [50,644 mi^2]; see Figure 1 and Table 1, below). Lynx populations in the DPS seem to function as peripheral subpopulations (islands) of a larger (mainland) metapopulation centered in north-central Canada (McKelvey *et al*. 2000b, p. 25; 68 FR 40077; also see 2.2 below), and the demographic and genetic health and persistence of DPS populations are thought to be influenced by connectivity with, and immigration of lynx from, larger populations in Canada (McKelvey *et al.* 2000b, pp. 21, 33; Schwartz *et al.* 2002, entire; 78 FR 59434, 59447; 79 FR 54815).

Lynx were documented historically in 24 of the Lower 48 States (McKelvey *et al.* 2000a, pp. 207-232), but records in many places are associated with cyclic "irruptions" of large numbers of lynx dispersing from southern Canada when hare populations crashed; many of these occurrences were in anomalous habitats, and lynx were unable to persist and establish populations in most of these areas (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 242, 253; Aubry 2006, pp. 1-2; ILBT 2013, p. 23; see also section 2.3.2, below). Habitats capable of supporting persistent resident lynx populations in the contiguous U.S. occur over a much smaller geographic area that includes parts of the Northeast (primarily northern Maine), western Great Lakes (northeastern Minnesota), Rocky Mountains (northern Idaho, northwestern Montana; perhaps also parts of northeastern Washington, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming, and parts of western Colorado), and the eastern Cascade Mountains of northern Washington (68 FR 40077-40080; U.S. Fish and Wildlife Service 2005, p. 3; 79 FR 54806-54807; Lynx SSA Team 2016, pp. 6-7). Although uncertainty remains regarding the historic distribution of resident lynx in the contiguous U.S., and breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population decline in the contiguous U.S. has been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11; also see section 2.3.2, below).

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 14 states in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on federal lands (65 FR 16052). In 2003, in response to a court memorandum opinion on the 2000 listing rule, the Service reaffirmed its determination of the lynx DPS and its status as threatened under the ESA (68 FR 40076). The Service completed a recovery outline in 2005 (U.S. Fish and Wildlife Service 2005, entire), designated critical habitat for the DPS in 2006 (71 FR 66008) and, in 2007, again in response to a court order, clarified its determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS (72 FR 1186). Also in 2007, the Service initiated a 5-year status review of the DPS (72 FR 19549). The Service revised the critical habitat designation for the DPS in 2009 (74 FR 8616) and 2014 (79 FR 54782) and, concurrent with the latter, rescinded the state-based definition of the DPS boundary to formally extend ESA protection to lynx "where found" in the contiguous U.S., including New Mexico and other states that were not included in the original DPS range (79 FR 54804). The Service reinitiated the 5-year status review in 2015 (https://www.fws.gov/mountain-prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php), and that

review will be informed by this SSA report. On September 7, 2016, the U.S. District Court for the District of Montana remanded the 2014 critical habitat designation to the Service for further consideration.

The six geographic units evaluated in this SSA encompass all areas of the contiguous U.S. that currently support or are believed to have recently supported persistent resident lynx populations (Figure 1). Five of the six geographic units were designated as “Core Areas” in the Recovery Outline (USFWS 2005, pp. 4-6, 21, 23), and western Colorado was designated a “Provisional Core Area” (USFWS 2005, pp. 6, 21, 23). With the exception of western Colorado, these units also encompass and closely mirror the areas the Service designated as critical habitat in 2014 (79 FR 54782). Some areas adjacent to but outside these geographic units are known or suspected to intermittently support lynx home ranges and occasional reproduction. Uncertainty remains as to whether resident lynx populations occurred historically in other areas not encompassed by the geographic units evaluated here.

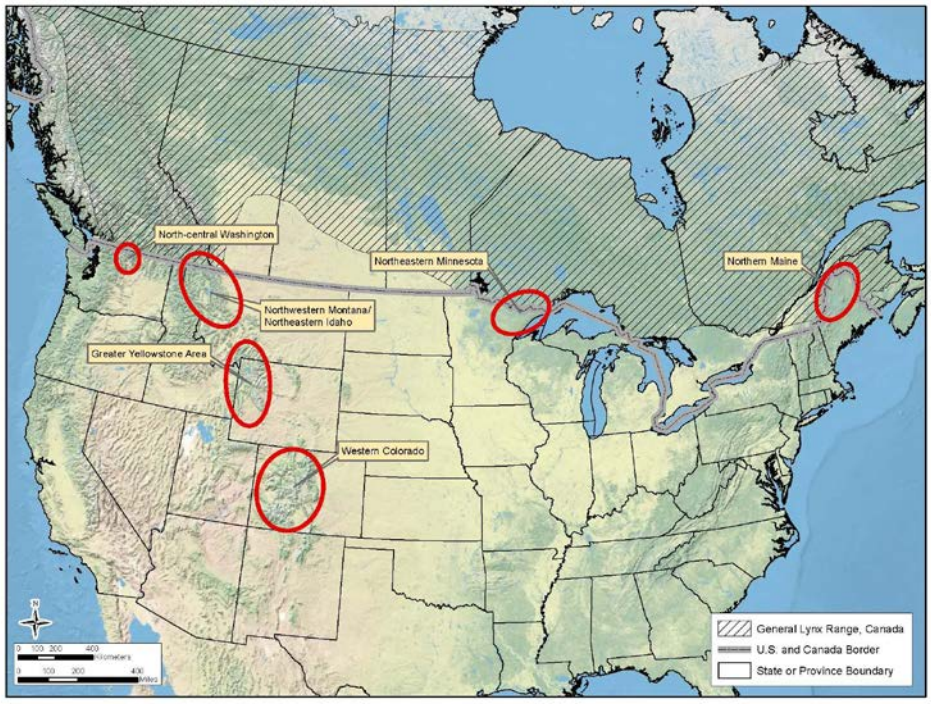


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*) that currently support or recently supported (GYA) resident lynx populations relative to the general range of lynx in Canada. Range in Canada based on Poole (2003), Koen *et al.* (2014), and Vashon (2015).

The six geographic units include federal, private, State, and Tribal lands. The amounts in each ownership vary among the units, with private lands predominating in Maine, a mix of ownerships in Minnesota, and federal lands predominating in the western units (Table 1).

Table 1. Lynx SSA Unit Sizes and Percent Ownership.

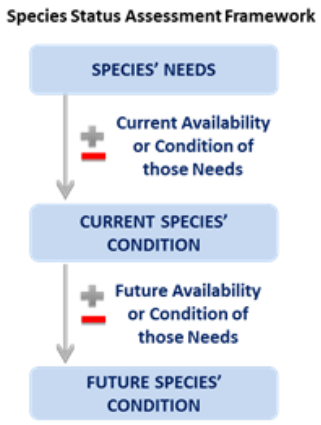
Unit[1]	Unit Size (km^2)	Percent of SSA Area	Land Ownership/Management (Percent)[2]						
			Federal				Private	State	Tribal
			All Federal	USFS	NPS	BLM			
1	28,909	22.0	0	0	0	0	91.6	7.3	0.9
2	21,101	16.1	47.4	44.9	2.5	0.01	15.5	36.2	1.0
3	26,997	20.6	84.3	69.3	13.6	1.5	8.0	4.1	3.5
4	5,176	3.9	91.5	84.6	6.7	0.1	0.3	8.2	0
5	23,687	18.1	97.6	79.7	16.7	1.1	2.2	0.3	0
6	25,294	19.3	90.1	85.2	1.8	3.1	9.3	0.6	0
All Units	131,164	100	63.6	55.6	6.8	1.1	26.5	8.8	1.1

[1] Unit 1 - Northern Maine; Unit 2 - Northeastern Minnesota, Unit 3 - Northwestern Montana/ Northeastern Idaho, Unit 4 - North-central Washington, Unit 5 - the Greater Yellowstone Area (southwestern Montana/Northwestern Wyoming), Unit 6 - Western Colorado.

[2] Unit sizes and ownership for units 1-5 are those calculated for the areas designated in 2014 as lynx critical habitat, including some Tribal, State and private lands that met the criteria for critical habitat but which were excluded from the designation in accordance with section 4(b)(2) of the Endangered Species Act. Unit 6 size and ownership were calculated by the Service's Western Colorado Field Office in coordination with Colorado Parks and Wildlife based on telemetry data from radio-marked lynx.

1.2 SSA Framework and Report

The Service is engaged in a number of efforts to improve the implementation of the ESA (see http://www.fws.gov/endangered/improving_ESA/). As part of this effort, our Endangered Species Program has developed the Species Status Assessment (SSA) Framework to guide how we assess the best scientific and commercial data available when evaluating the biological status of species. In conducting an SSA, we take into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time (captured under the broad heading of "species needs"); the current condition of the species at the individual, population, and range-wide levels in terms of meeting those needs; and the likely changes in the environment that may influence the species' future condition and, thus, the viability of the species.



The SSA Framework defines viability as a description of the ability of a species to sustain populations in the wild beyond a biologically meaningful time frame[1]. Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3 Rs") as a lens to evaluate the current and future condition of the species. Briefly, resiliency describes the ability of the species to withstand stochastic events; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. As a result, the SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings. Importantly, the SSA neither results in, nor predetermines, any decisions by the Service under the ESA.

The Species Status Assessment Report (SSA Report) is a summary of the information assembled, reviewed, and assessed by the Service and is based on the best scientific and commercial data available at the time of the assessment. Completed SSA Reports and supporting material can be found at the collaborative repository of the National Park Service and the USFWS called "ServCat" at the following IP address: *http://www.fws.gov/Refuges/NaturalResourcePC/landM/serviceCatalog.html*.

1.3 Analytical Approach/Methods

We used the SSA Framework (October 2015, version 3.3) described above to evaluate the current status of resident lynx in the contiguous U.S. as well as the likelihood that the geographic areas supporting resident lynx in the DPS would continue to do so in the near term and at mid- and end-of-century (years 2025, 2050, and 2100). We framed our evaluation in

[1] Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations in the wild over time. USFWS. 2015. Species Status Assessment Framework. Version 3.3. October 2015.

terms of the 3 Rs using conceptual modeling (Figure 2) based on available published literature, other information on the historic and current status of and threats to lynx in the DPS and, where empirical data are lacking, on formally-elicited expert opinion and best professional judgment (Lynx SSA Team 2016, entire).

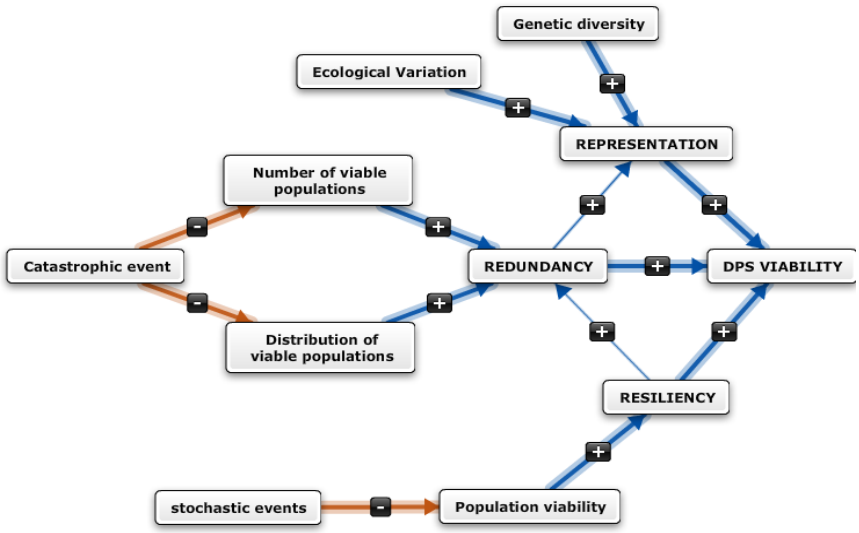


Figure 2. Conceptual model of the factors thought to influence the 3 Rs as they pertain to lynx viability.

We applied the definitions from the SSA Framework for the principles of redundancy, representation, and resiliency, provided in section 1.2, to Canada lynx as described below. We evaluated redundancy and representation at the scale of the DPS as a whole, and resiliency at the scale of lynx populations within each of the six geographic units.

To evaluate **redundancy** for the lynx DPS, we considered the current and likely future geographic distributions of resident breeding populations and whether the DPS is currently vulnerable to extirpation due to catastrophic event or would be in the future. Figure 3 shows examples of relationships among factors that may influence redundancy within the lynx DPS.

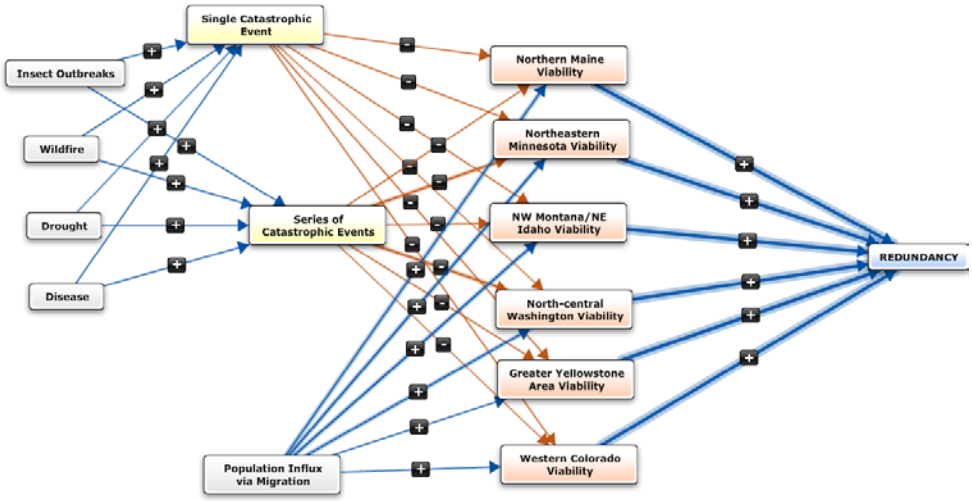


Figure 3. Conceptual model of factors thought to influence redundancy within the lynx DPS.

To evaluate **representation** for the lynx DPS, we considered measures of genetic diversity and heterozygosity, the current and likely future ecological diversity of geographic areas occupied by resident breeding populations, and the documented dispersal capabilities of the species, as shown in Figure 4 below.

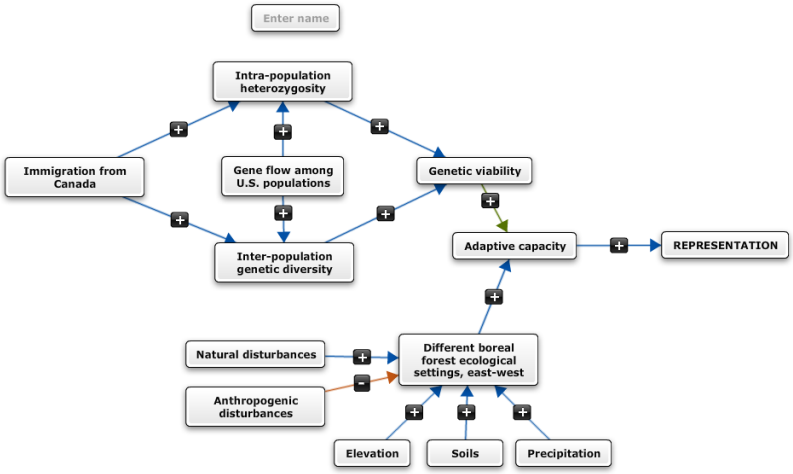


Figure 4. Conceptual model of factors thought to influence representation within the lynx DPS.

Because we lack reliable estimates of population sizes and trends, growth rates, and other long-term demographic data for most populations in the DPS, our evaluation of the **resiliency** of lynx

populations in the DPS was based largely on consideration of recent status updates and formally-elicited expert opinion regarding the likelihood that DPS populations will remain viable into the future. The relationships among factors that influence DPS resiliency are shown in Figure 5 below.

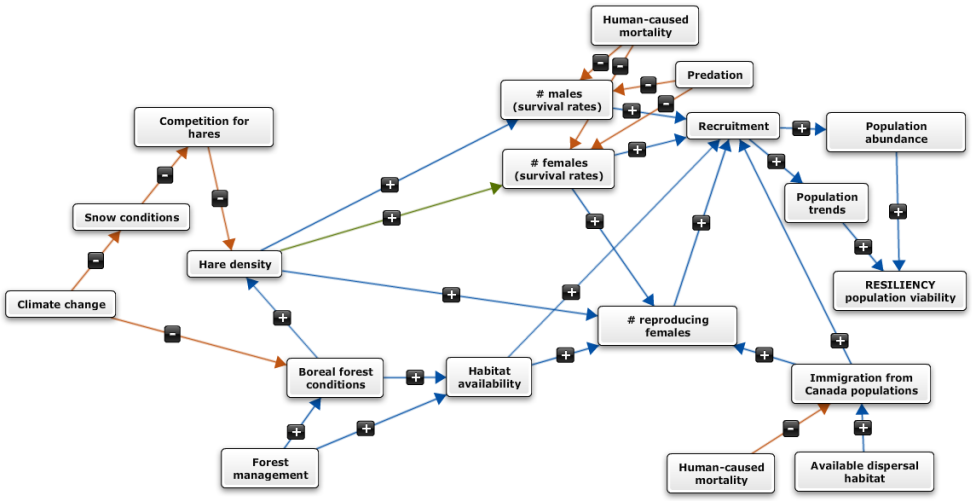


Figure 5. Conceptual model of factors thought to influence the resiliency of lynx populations within the DPS.

Chapter 2: Lynx Ecology

In this chapter, we describe the physical characteristics, taxonomy, and genetics of the Canada lynx, its life history and population dynamics, and its taxon-wide and DPS distributions. We rely heavily on recent summaries of this information provided in the revised *Canada Lynx Conservation Assessment and Strategy* (LCAS; ILBT 2013, entire), the Service's recent proposed (2013) and final (2014) rules to revise the designation of critical habitat for the DPS (78 FR 59430-59474; 79 FR 54782-54846), and the results of an October 2015 lynx expert elicitation workshop (Lynx SSA Team 2016, entire). We also provide a summary of the pertinent ecological requirements of lynx at the individual, population, and DPS levels. These ecological requirements form the basis of our analyses conducted in Chapters 3 through 5.

2.1 Species Taxonomy, Description, and Genetics

The Canada lynx (order Carnivora; family Felidae) is one of four species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). There are

three recognized subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. mollipilosus* ("Arctic lynx," Stone 1900), and *L. c. subsolanus* ("Newfoundland lynx," Bangs 1897) (Integrated Taxonomic Information System online database, http://www.itis.gov, retrieved April 14, 2016).

The Canada lynx is a medium-sized cat with long legs and large, well-furred paws. In winter, the lynx's fur is dense and has a grizzled appearance with a grayish-brown mix of buff or pale brown fur on the back, and a grayish-white or buff-white fur on the belly, legs, and feet. In summer, its fur is more reddish to gray-brown (McCord and Cardoza 1982, p. 730). It has long tufts of black hairs extending from the tips of its ears, a short, completely black-tipped tail, and often a distinct dish-like facial ruff of pale hairs tipped black. Lynx generally measure 75 to 90 cm (30 to 35 in) long and weigh 6 to 14 kg (14 to 31 lb) (Quinn and Parker 1987, Table 1; Moen *et al.* 2010a, Figure 2; Maine Department of Inland Fisheries and Wildlife 2012, unpublished data), and males are 13-25 percent larger than females (Mowat *et al.* 2000, p. 267). The lynx's large feet and long legs make it highly adapted for traversing and hunting in deep, powdery snow, where its low foot-loading (weight per surface area of foot) is thought to provide a competitive advantage (Buskirk *et al.* 2000a, p. 90; 2000b, p. 400; ILBT 2013, pp. 26, 36, 81) over other terrestrial predators of snowshoe hares, the lynx's primary prey. In southern Canada and the northern contiguous U.S, where the southern edge of the lynx range overlaps the northern edge of the bobcat range, the two species are easily confused because of their similar size and appearance. However, the lynx's longer ear-tufts, larger feet, and black-tipped tail distinguish it from the bobcat, which has shorter ear tufts, small feet, white on the underside of the tail, and is much more common and abundant than lynx in most of the contiguous U.S..

Overall, genetics research suggests high gene flow across most of the continental range of lynx, likely because of high dispersal rates, large dispersal distances, and the absence of significant barriers to genetic interchange throughout much of the lynx range, including the DPS (Schwartz *in* Lynx SSA Team 2016, pp. 11-12). Genetic evidence also indicates interactions between lynx populations even where physical barriers appear most likely to restrict gene flow. For example, although *L. c. subsolanus* on Newfoundland Island is genetically (Row *et al.* 2012, pp. 1262-1266; Koen *et al.* 2015, p. 528) and morphologically (Khidas *et al.* 2013, pp. 597-601) distinct from mainland lynx, there is evidence of genetic exchange between the two areas, indicating that some lynx are able to cross the 15-60 km-wide (9-37 mi) Strait of Belle Isle that separates them (Koen *et al.* 2015, p. 527). Similarly, despite some differences in functional genetic markers (unique alleles) in lynx south versus north of the St. Lawrence Seaway/River in eastern Canada, which suggest the potential for evolutionarily significant differences in those areas, recent analyses reveal genetic exchange among lynx on either side, indicating that some lynx successfully navigate this barrier (Koen *et al.* 2015, pp. 524-528; Bowman *in* Lynx SSA Team 2016, p. 12-13).

Schwartz *et al.* (2003, entire) documented reduced genetic variation (lower mean number of alleles per population and lower expected heterozygosity) among peripheral lynx populations compared to populations in the core of the lynx geographical range in Canada and Alaska. While recognizing that small changes in genetic variation can lead to large changes in

population fitness, the authors noted that the differences between core and peripheral populations in their study were small enough to suggest a lack of significant population subdivision (i.e., no indication of genetic isolation, substantial genetic drift, or potential genetic ‘‘bottlenecks’’ among DPS populations; Schwartz *et al.* 2003, p. 1814; 79 FR 54793). This finding is consistent with their earlier work, which documented high levels of gene flow (the highest yet documented for any carnivore) between core and peripheral lynx populations despite large separation distances (Schwartz *et al.* 2002, entire). Their results did not suggest that reduced genetic variation among peripheral populations was because of human disturbance (i.e., habitat loss/ fragmentation on the southern periphery of the geographic range; Schwartz *et al.* 2003, p. 1814), but they did imply that the persistence of lynx populations in the contiguous U.S. depends on dispersal from larger (core) populations (Schwartz *et al.* 2002, p. 522). Currently, there is no indication that the levels of connectivity and gene flow between lynx populations in the DPS and those in the core of the lynx’s range are inadequate to maintain the genetic health of DPS populations. Given the connectivity of most DPS units with lynx populations and habitats in Canada, the noted dispersal capabilities of lynx, evidence of dispersal in both directions across the Canada-U.S. border (Aubry *et al.* 2000, pp. 386-387; Squires *et al.* 2006a, p. 38; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and the small number of immigrants thought necessary to maintain genetic variability in peripheral populations (McKelvey *et al.* 2000b, pp. 23-24), genetic isolation, biologically meaningful genetic drift, or potential genetic ‘‘bottlenecks’’ appear unlikely among most DPS populations in the future (79 FR 54793).

Within the contiguous U.S., minor genetic sub-structuring has been documented among lynx subpopulations in western Montana (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5). Additionally, lynx-bobcat hybridization has been documented in Minnesota, Maine and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where male bobcats bred with female lynx to produce fertile offspring with lynx-like ear tufts, intermediate foot-size, and bobcat-like fur (ILBT 2013, p. 35). In Minnesota from 2000 to 2015, DNA analyses documented 13 distinct hybrid individuals (Moen and Catton *in* Lynx SSA Team 2016, pp. 13, 19); no hybrids have been documented in the western portion of the lynx’s range (Schwartz *in* Lynx SSA Team 2016, p. 12).

2.2 Life History and Population Dynamics

All aspects of lynx life history are inextricably tied to its primary prey, the snowshoe hare (Figure 6). Snowshoe hares comprise a majority of the lynx diet throughout its range (Nellis *et al.* 1972, pp. 323–325; Brand *et al.* 1976, pp. 422–425; Koehler 1990, p. 848; Apps 2000, pp. 358–359, 363; Aubry *et al.* 2000, pp. 375–378; Mowat *et al.* 2000, pp. 267–268; von Kienast 2003, pp. 37–38; Squires *et al.* 2004a, p. 15, Table 8, Olson 2015, pp. 60-69), and hare abundance is the major driver of lynx population dynamics. Lynx den site selection, litter sizes, pregnancy, as well as recruitment, survival (kitten, subadult and adult) and dispersal rates, and population age structure, home range sizes, density, and distribution are all strongly influenced by hare abundance (Koehler and Aubry 1994, pp. 75-76, 80-83; Apps 2000, entire; Aubry *et al.* 2000, pp. 375-390; Mowat *et al.* 2000, pp. 270-294; ILBT 2013, pp. 18, 22-24, 26-34).

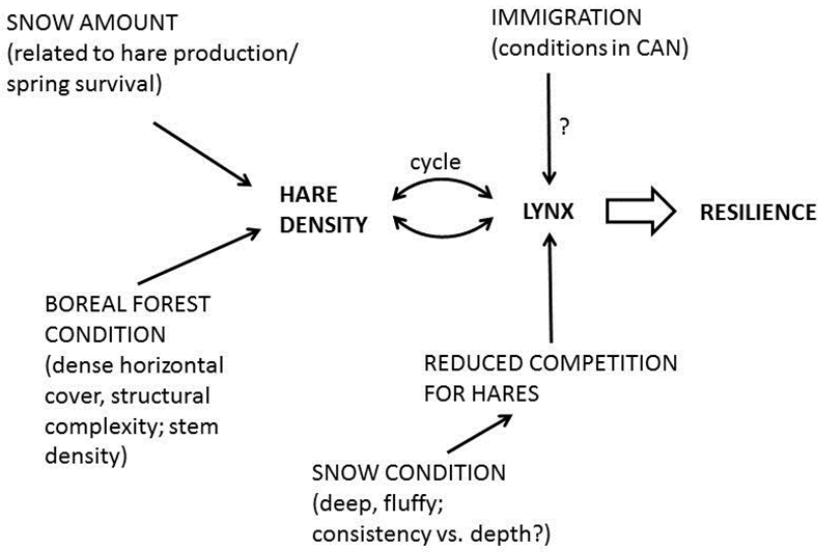


Figure 6. Generalized relationship between habitat conditions and hare and lynx population dynamics and their influence on lynx population resiliency.

Lynx are highly specialized predators of snowshoe hares and are dependent on landscapes with high-density snowshoe hare populations for survival and reproduction (McCord and Cardoza 1982, p. 744; Quinn and Parker 1987, pp. 684-685; Aubry *et al.* 2000, pp. 375-378). Lynx and snowshoe hares are strongly associated with what is broadly described as boreal forest (Bittner and Rongstad 1982, p. 154; McCord and Cardoza 1982, p. 743; Quinn and Parker 1987, p. 684; Agee 2000, p. 39; Aubry *et al.* 2000, pp. 378-382; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-191; McKelvey *et al.* 2000a, pp. 211-232). The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (*Picea* spp.) and fir (*Abies* spp.) (Elliot-Fisk 1988, pp. 34-35, 37-42). Snowshoe hares feed on conifers, deciduous trees, and shrubs (Hodges 2000b, pp. 181-183) and are most abundant in forests with dense understories that provide forage, cover to escape from predators, and protection during extreme weather (Wolfe *et al.* 1982, pp. 665-669; Litvaitis *et al.* 1985, pp. 869-872; Hodges 2000a, pp. 136-140 and 2000b, pp. 183-195). Over much of the lynx's range, hare densities are higher in regenerating, earlier successional forest stages because they often have greater understory structure than mature forests (Buehler and Keith 1982, p. 24; Wolfe *et al.* 1982, pp. 665-669; Koehler 1990, pp. 847-848; Hodges 2000b, pp. 183-195; Homyack 2003, pp. 63, 141; Griffin

2004, pp. 84-88). However, snowshoe hares also can be abundant in mature forests with dense understories, particularly in the Northern Rocky Mountains (Griffin 2004, pp. 53-54; Griffin and Mills 2009, pp. 1492-1496; Hodges *et al.* 2009, p. 876; Squires *et al.* 2010, pp. 1653-1657; Berg *et al.* 2012, pp. 1483-1487). These mature forests may be a source of hares for other adjacent forest types (Griffin and Mills 2009, pp. 1492, 1495-1496), and they may provide especially important winter foraging habitats (Squires *et al.* 2010, pp. 1655-1657), which may be the most limiting habitat for lynx (Squires *et al.* 2010, pp. 1655-1657; ILBT 2013, pp. 17, 27). They also are more temporally-stable (i.e., they provide high-quality hare habitat for a longer period of time) than regenerating stands, which may foster high hare densities for a variable window of time between stand-initiation and stem-exclusion stages of succession, after which they may persist, in the absence of disturbance, for many years as lower-quality hare habitat (ILBT 2013, pp. 62, 71, 127).

Lynx habitat can generally be described as moist boreal forests that have cold, snowy winters and a snowshoe hare prey base (Quinn and Parker 1987, pp. 684-685; Agee 2000, pp. 39-47; Aubry *et al.* 2000, pp. 373-375; Buskirk *et al.* 2000b, pp. 397-405; Ruggiero *et al.* 2000b, pp. 445-447). Because lynx population dynamics, survival, and reproduction are closely tied to snowshoe hare availability, snowshoe hare habitat is the primary component of lynx habitat. However, lynx do not occur everywhere within the range of snowshoe hares in the contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729). This may be due to inadequate abundance, density, or spatial distribution of hares in some places, or the absence of snow conditions that would allow lynx to express a competitive advantage over other hare predators, or a combination of these factors (79 FR 54809).

The boreal forest landscape is naturally dynamic. Forest stands within the landscape change as they undergo succession after natural or human-caused disturbances such as fire, insect epidemics, wind, ice, disease, and forest management (Elliot-Fisk 1988, pp. 47-48; Agee 2000, pp. 47-69). As a result, lynx habitat within the boreal forest landscape is a shifting mosaic of habitat patches of variable and continually changing quality (68 FR 40077). These stands of differing ages and conditions provide lynx foraging or denning habitat (or may provide these in the future depending on patterns of disturbance and forest succession), and some serve as travel routes for lynx moving between foraging and denning habitats (McKelvey *et al.* 2000c, pp. 427-434; Hoving *et al.* 2004, pp. 290-292). Lynx generally concentrate hunting activities in areas where snowshoe hare densities are high (Koehler *et al.* 1979, p. 442; Ward and Krebs 1985, pp. 2821-2823; Murray *et al.* 1994, p. 1450; O'Donoghue *et al.* 1997, pp. 155, 159-160 and 1998, pp. 178-181; Fuller and Harrison 2010, entire; Simons-Legaard *et al.* 2013, pp. 573-575). Because understory density within a forest stand changes over time, hare habitat quality and corresponding hare densities also shift continually across boreal forest landscapes.

Hare populations in the core of the lynx range in Canada and Alaska undergo well-documented dramatic 8 to 11 year cycles during which hare numbers may fluctuate 10 to 25 fold or more, with peak densities as high as 23 hares/hectare (ha; 9.3 hares/acre [ac]) and lows of 0.1/ha (0.04/ac) (Hodges 2000a, pp. 117-121; Vashon 2015, p. 4). Hare densities are generally lower at the southern periphery of lynx distribution, and hare population cycles are generally much

less pronounced or absent entirely among some hare populations in southern Canada and in the contiguous U.S. (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17). In the contiguous U.S., stand-level hare densities may exceed 2 hares/ha (0.8 hares/ac) (Walker 2005, pp. 20, 85; McCann 2006, p. 15; Robinson 2006, pp. 26-36, 62-75; Homyack *et al.* 2007, pp. 10-11; Griffin and Mills 2009, p. 1492; Vashon *et al.* 2012, p. 14), but in many parts of the DPS, landscape-level densities are lower, ranging from just above to well below the 0.5 hares/ha (0.2/ac) density thought necessary to sustain lynx home ranges and populations (Hodges 2000b, pp. 168-169, 185; Ruggiero *et al.* 2000b, pp. 446–447; Squires and Ruggiero 2007, pp. 313-314; Maletzke *et al.* 2008, pp. 1476-1477; Zahratka and Shenk 2008, pp. 910-911; Hodges *et al.* 2009, pp. 873-877; Ivan 2011a, pp. 91-92, 95-102; Berg *et al.* 2012, p. 1483; ILBT 2013, pp. 24, 26, 90).

During lows in snowshoe hare populations, lynx prey opportunistically on other small mammals, especially red squirrels (*Tamiasciurus hudsonicus*), and birds, but alternate prey species do not sufficiently compensate for low availability of snowshoe hares, and lynx populations cannot persist over time in areas with consistently low hare densities (Brand *et al.* 1976, pp. 422–425; Brand and Keith 1979, pp. 833–834; Koehler 1990, pp. 848–849; Mowat *et al.* 2000, pp. 267–268). Nonetheless, even in areas with relatively low or marginal hare densities, hares constitute the majority of the biomass in lynx diets (Koehler and Aubry 1994, p. 85; Apps 2000, pp. 362-363; Aubry *et al.* 2000, pp. 375-378; Roth *et al.* 2007, pp. 2740-2741; Squires and Ruggiero 2007, pp. 310-313; Hanson and Moen 2008, p. 9; Maletzke *et al.* 2008, pp. 1475-1477; Shenk 2009, pp. 13, 16; Ivan *in* Lynx SSA Team 2016, Appendix 3, pp. 13-14).

Lynx typically mate in March and April, and kittens are born from late April to mid-June after a 60- to 70-day gestation period (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Female lynx typically reach reproductive maturity in their second year (at 22 months of age); however, when hares are abundant, females may breed at 10 months of age and produce kittens as 1-year-olds (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Males do not seem to breed as yearlings, and they do not contribute to rearing of young (ILBT 2013, p. 30). Lynx dens are typically located in areas of dense cover, where coarse woody debris, such as downed logs and windfalls, provides security and thermal cover for lynx kittens (McCord and Cardoza 1982, pp. 743-744; Koehler 1990, pp. 847-849; Slough 1999, p. 607; Squires and Laurion 2000, pp. 346-347; Organ *et al.* 2008, entire; Squires *et al.* 2008, pp. 1497, 1501-1505; Moen and Burdett 2009, entire). Dens have been documented in both mature and younger boreal forest stands (Mowat *et al.* 2000, pp. 274-275; Squires *et al.* 2008, p. 1497; ILBT 2013, pp. 29-30; 78 FR 59441-59442; 79 FR 54809-54810; Organ *et al.* 2008, entire), and the amount of structure (e.g., downed, large, woody debris, tip-up mounds) seems to be more important than the age of the forest stand for lynx denning habitat (Mowat *et al.* 2000, pp. 274-275, Organ *et al.* p. 1516). Denning habitat is not thought to be a limiting factor for lynx in the DPS (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517; Squires *et al.* 2008, p. 1505; ILBT 2013, p. 30; 79 FR 54790). Dens must be near foraging habitat to allow females to adequately provision dependent kittens, and females seem to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.*

2012, p. 16; ILBT 2013, p. 29). Females attend kittens at the natal den site and one or more alternate or maternal dens until kittens are about 6-10 weeks old (Squires *et al.* 2008, p. 1502; Vashon *et al.* 2012, p. 17; ILBT 2013, p. 29). Thereafter, kittens remain with their mothers through their first winter, apparently learning from her how to hunt and capture prey, initially on a small portion of her home range, but by fall on the larger area the female used before kittens were born (Mowat *et al.* 2000, pp. 269, 278). Juveniles remain closely associated with their mothers until February or March, when family groups begin to break up, with young typically dispersing in April and May (Mowat *et al.* 2000, pp. 278-279) to establish their own home ranges. Female offspring may establish home ranges overlapping or adjacent to their mother's home range and maintain mother-daughter bonds throughout their lives (Mowat *et al.* 2000, pp. 279-280). Male home ranges may slightly overlap adjacent male home ranges. While male home ranges typically overlap one to three female home ranges, and female home ranges are partially or completely encompassed by a male's home range, core areas within home ranges appear to be exclusive except during the breeding season (Koehler and Aubry 1994, pp. 90-91; Mowat *et al.* 2000, pp. 276-280; Vashon *et al.* 2012, pp. 17, 22-23). Fidelity to home ranges over several years has been documented for both sexes, but shifts and abandonment of home ranges have also been documented (Koehler and Aubry 1994, p. 91; Mowat *et al.* 2000, p. 277). Lynx have been documented to live up to 16 years in the wild (Kolbe and Squires 2006, entire).

Lynx populations in Canada fluctuate in response to the cycling of hare populations (Elton and Nicholson 1942, pp. 241–243; Hodges 2000a, pp. 118–123; Mowat *et al.* 2000, pp. 265–272), with synchronous fluctuations in lynx numbers emanating from the core of the Canadian population and spreading over vast areas, generally lagging hare numbers by one year (McKelvey *et al.* 2000a, pp. 232, 239; Mowat *et al.* 2000, pp. 266, 270). When hares are abundant, lynx have higher pregnancy rates and larger litter sizes, higher kitten survival, and lower adult mortality, resulting in rapid population growth during the increase phase of the hare cycle (Slough and Mowat 1996, pp. 955–956; Mowat *et al.* 2000, pp. 266, 270–272, 281–289). When hare populations are low, female lynx produce few or no kittens that survive to independence (Nellis *et al.* 1972, pp. 326–328; Brand *et al.* 1976, pp. 420, 427; Brand and Keith 1979, pp. 837–838, 847; Poole 1994, pp. 612–616; Slough and Mowat 1996, pp. 953–958; O'Donoghue *et al.* 1997, pp. 158–159; Aubry *et al.* 2000, pp. 388–389; Mowat *et al.* 2000, pp. 285–287). When hares decline, lynx mortality rates increase, largely because of starvation, and home range sizes and dispersal/ emigration rates also increase (Ward and Krebs 1985, pp. 2821–2823; O'Donoghue *et al.* 1997, pp. 156, 159; Poole 1997, pp. 499–503; Mowat *et al.* 2000, pp. 265–272, 278, 281–294). Lynx numbers decline dramatically during the ''crash'' phase of the hare cycle (Slough and Mowat 1996, p. 956; Mowat *et al.* 2000, pp. 283-285), when many lynx starve and many others abandon home ranges and disperse in search of food, with many of the latter also dying, often soon after initiating dispersal (Mowat *et al.* 2000, p. 293).

In Canada, lynx abundance may be 3 to 17 times higher at the peak versus the low of the hare cycle, with lynx densities reaching 30-45/100 km^2 (78-117/100 mi^2) in optimal dense regenerating forests 15-40 years post-fire, 8-20/100 km^2 (21-52/100 mi^2) in older forests or further south, and < 3/100 km^2 (< 8/100 mi^2) at the hare cycle low (Slough and Mowat 1996, pp.

952, 955; Mowat *et al.* 2000, p. 283; Hatler and Beal 2003, pp. 2, 5; Environment Canada 2014, p. 1). In southern Canada, where hares are less abundant and hare population cycles are muted or absent, lynx populations may be stable at 2-3/100 km^2 (5-8/100 mi^2) (Environment Canada 2014, p. 1). Lynx densities estimated in the contiguous U.S. have ranged from 9.2-13/100 km^2 (24-34/100 mi^2), including kittens, in Maine's highest-quality habitat when hares were abundant (Vashon *et al.* 2008, pp. 1483-1484; Vashon *et al.* 2012, pp. 14-15) to 2.3/100 km^2 (6/100 mi^2) in Washington when hare abundance was low (Koehler 1990, pp. 847-850). Correspondingly, hare abundance may also influence lynx home range size. Ward and Krebs (1985, pp. 2819-2820) documented a 3-fold increase in home range size in southwestern Yukon, from 13 km^2 (5 mi^2) on average when hares were abundant and increasing to 39 km^2 (15 mi2) when hare density was low. Poole (1994, pp. 613-614) documented a similar trend in the Northwest Territories, where lynx home range size increased from 17 km^2 (7 mi^2; males and females combined) when hares were abundant, to 44 km^2 (17 mi^2) and 62 km^2 (24 mi^2) for males and females, respectively, when hare numbers declined. In contrast, Breitenmoser *et al.* (1993, p. 552) reported no change in lynx home range size despite a 10-15 fold increase in lynx density as hare abundance increased in the southern Yukon. Similarly, in Maine, lynx home range size did not increase when hare densities declined from 2/ha (0.8/ac) to 1/ha (0.4/ac) (Mallett 2014, pp. 53-93). In general, hare and lynx densities are lower and lynx home ranges larger at the southern periphery of the lynx's range, including most of the contiguous U.S., and are similar to those of northern populations during the low phase of the hare population cycle (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367).

Lynx populations in the contiguous U.S. seem to function as subpopulations or southern extensions of larger populations in northern and eastern Canada (McKelvey *et al.* 2000b, pp. 21, 25, 33; 65 FR 16052–16082; 68 FR 40077–40099; 71 FR 66025–66035; 74 FR 8616–8641; Koen *et al.* 2015, pp. 527-528). Populations in the DPS are relatively isolated from one another, though most are directly connected via dispersal to lynx populations in Canada (McKelvey *et al.* 2000b, pp. 25-34; U.S Fish and Wildlife Service 2005, p. 2). Lynx disperse in both directions across the Canada–U.S. border (Aubry *et al.* 2000, pp. 386-387; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and this connectivity and interchange with lynx populations in Canada is thought to be important to the conservation of lynx populations in the DPS. (McKelvey *et al.* 2000b, p. 33; Schwartz *et al.* 2002, p. 522; U.S Fish and Wildlife Service 2005, p. 2; ILBT 2013, p. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187). However, whether and, if so, to what the extent the demographic and genetic health and persistence of populations in the DPS depend on regular or intermittent immigration of lynx from Canada remains uncertain (McKelvey *et al.* 2000a, pp. 241-242; 79 FR 54793).

2.2.1 Ecological Requirements of Individuals

At the most fundamental level, the needs of an individual lynx are met if:

1) it is born to a female that occupies a home range containing
    a) secure denning habitat,

b) adequate hare abundance to support lactation during the early kitten stage and later provisioning of the kitten with hare meat,
c) habitat (boreal forest and snow) conditions that reduce the likelihood and effect of competition from other hare predators, and
d) a low likelihood of encounters with lynx mortality agents (predators, trappers, vehicles, etc.);

2) the mother's home range occurs within a larger landscape that also contains adequate hare abundance and available habitat into which the yearling lynx may disperse and establish its own home range after the period of maternal dependence, with low likelihood of adverse competition and mortality; and

3) the larger landscape also supports other secure lynx home ranges and ensures the opportunity to encounter a lynx of the opposite sex, breed successfully, and contribute to the recruitment of at least one offspring into the breeding population during its lifetime.

In cyclic northern lynx populations, there is a strong element of timing that determines whether these individual needs will be met. During the decline and low phases of the hare population cycle, few kittens are born, very few survive until their first winter, and recruitment may collapse completely or nearly so for several successive years (Slough and Mowat 1996, entire; Mowat *et al.* 2000, pp. 266, 285-287). Therefore, even in the core of the species' range, a kitten born during a period of declining or low hare abundance is very unlikely to survive to independence, breed successfully, and replace itself within the breeding population in its lifetime. Conversely, a kitten born during the increase or high phase of the hare population cycle is much more likely to survive, establish a home range, breed successfully, and replace itself via recruitment of one or more of its offspring into the breeding population.

In southern lynx populations (southern Canada and the contiguous U.S.), hare population cycles are of lower amplitude or absent (Hodges 2000b, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17), and hare and lynx abundances and lynx demographic rates are typically like those of northern populations during hare lows (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367). Therefore, the likelihood that an individual lynx will have its ecological requirements met sufficiently so that it may replace itself in the breeding population is probably consistently relatively low, perhaps similar to lynx born during hare declines/lows in the north. Also in the south, there are more diverse assemblages of potential competitors and predators, more natural patchiness and anthropogenic fragmentation of lynx habitat (fewer areas with adequate hare densities and favorable snow conditions distributed broadly across large landscapes), and higher road densities and, thus, greater potential for lynx-vehicle collisions (Wolff 1980, p. 128; Buskirk *et al.* 2000a, entire). These factors probably further reduce the likelihood that an individual lynx in the southern periphery of the range will survive, reproduce successfully, and have one or more offspring recruited into the resident breeding population.

Individual lynx require large areas of boreal forest landscapes to support their home ranges, provide hares in adequate abundance to meet their nutritional needs, provide breeding opportunities, and facilitate dispersal and exploratory travel. Female home ranges must also provide secure denning habitat in close proximity to foraging areas with high hare densities to allow females to adequately provision dependent kittens, and females appear to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). The size of lynx home ranges is strongly influenced by the quality of the habitat, particularly the abundance of snowshoe hares, in addition to other factors such as gender, age, season, and density of the lynx population (Aubry *et al.* 2000, pp. 382–385; Mowat *et al.* 2000, pp. 276–280). Generally, females with kittens have the smallest home ranges, likely related to their need to stay close to dens and dependent kittens, and males have the largest home ranges (Moen *et al.* 2005, p. 11; Burdett *et al.* 2007, p. 463; ILBT 2013, p. 24).

The increased natural patchiness and fragmentation of high-quality hare habitat where boreal forest conditions transition to temperate forest types require individual lynx in many parts of the DPS to maintain relatively large home ranges that include patches of higher hare densities within a matrix of lower-quality habitats with lower hare densities (ILBT 2013, p. 126; 78 FR 59434; also see 2.3.3, below). Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range (78 FR 59438). Annual home range sizes reported for lynx in the contiguous U.S. (Table 2, below) vary greatly across the DPS but are generally larger in the west than the east; however, differences should be interpreted with caution because different methods, sample sizes, and estimators were used to generate them (ILBT 2013, pp. 23-24).

Table 2. Reported annual home range sizes for Canada lynx in the contiguous United States.

Geographic Unit	Reported Lynx Home Range Size km^2 (mi^2)		References (pages)
	Female	Male	
N Maine	26 (10)	54 (21)	Vashon *et al.* 2012 (16-17)
NE Minnesota	17-21 (7-8)	160-267 (62-103)	Burdett *et al.* 2007 (460-463); Moen *et al.* 2008a (17)
NW Montana/ NE Idaho	43-115 (17-44)	122-238 (47-91)	Brainerd 1985 (20); Squires and Laurion 2000 (344); Squires *et al.* 2004a (13)
N-C Washington	37-91 (14-35)	49-69 (19-27)	Brittell *et al.* 1989 *in* Stinson 2001 (5); Koehler 1990 (847); Maletzke *in* Lynx SSA Team 2016 (21)
GYA	50 (19)	824 (318)	Squires *et al.* 2003 (12-13)

Comment [30]: Some of these home ranges seem to be presented as a range of values and others (e.g., ME, GYA) are a single value (a mean?). We should be consistent and present a mean and range, if these data are available.

W Colorado	75-704 (29-272)	103-387 (40-149)	Shenk 2008 (10)

Juvenile and adult lynx require about 400 and 600 grams (14 and 21 ounces) of food per day (for adults, 0.4-0.5 hares/day, 170-200 hares/year), respectively, to meet their basic nutritional requirements (Saunders 1963, p. 390; Nellis *et al.* 1972, pp. 324-325). Available research suggests that landscape-level hare densities >= 0.5 hares/ha (0.2/ac) are necessary to support lynx home ranges and resident breeding populations; lynx home range abandonment, dispersal, and mortality increase when hare densities are lower; and lynx may be unable to survive where landscape hare densities are below 0.3/ha (0.12/ac) (Ward and Krebs 1985, pp. 2819-2822; Slough and Mowat 1996, entire; Ruggiero *et al.* 2000b, pp. 446-447; ILBT 2013, pp. 26, 125). Recent research in the contiguous U.S. supports this - in northern Maine, areas with landscape hare densities of 0.74/ha (0.30/ac) supported resident breeding lynx, but areas with hare densities below 0.5/ha (0.2/ac) were not occupied by lynx (Simons-Legaard *et al.* 2013, pp. 567, 574-575). Likewise, in northeastern Minnesota, resident lynx maintained home ranges where landscape hare densities were 0.64/ha (0.26/ac). Voyageurs National Park, where hare density was estimated at 0.35/ha (0.14/ac), did not support resident breeding lynx (Moen *et al.* 2012, pp. 352–354).

In addition to adequate hare density, individual lynx require landscapes in which they are unlikely to encounter predators (mountain lion [*Puma concolor*], coyote [*Canis latrans*], wolverine [*Gulo gulo*], gray wolf [*Canis lupus*], fisher [*Pekania pennanti*], and other lynx) (ILBT 2013, pp. 33, 35). Although lynx have co-evolved with predators, the influence of predation on lynx populations is unknown (ILBT 2013, pp. 35-36), and mountain lions and coyotes are now more widespread and abundant in the southern periphery of the lynx distribution than they seem to have been historically (Buskirk *et al.* 2000a, p. 83; Gompper 2002, entire). Lynx also need landscapes where they are unlikely to suffer reduced fitness because of competition with other hare predators, or encounter traps or other anthropogenic causes of mortality. Except for fisher and marten (*Martes americana*), lynx predators and potential terrestrial competitors for hares (the species above plus bobcat; maybe red fox [*Vulpes vulpes*] in some situations) all have higher foot-loading (weight per surface area of the foot), making them less efficient at traveling and hunting in the deep powdery snow conditions favorable for lynx (Buskirk *et al.* 2000a, pp 86-95, Krohn *et al.* 2005, entire) and, therefore, likely limiting, at least seasonally, interactions between lynx and these species. Analysis of lynx occurrence data in the contiguous U.S. suggests that lynx require at least four months (December through March) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Where snow conditions do not consistently favor lynx, increased potential for predation and competition would be expected (Peers *et al.* 2013, p. 8). Finally, individual lynx are more likely to survive, breed, and replace themselves in the breeding population if they occupy home ranges where trapping is prohibited or trapping pressure is low (Slough and Mowat 1996, entire), high-speed/ high-volume roadways are absent (ILBT 2013, pp. 77-78), and other potential anthropogenic causes of lynx mortality are minimal.

In summary, individual lynx require large landscapes with hare densities that maximize their chances of (1) surviving to independence, (2) establishing and maintaining a home range, (3) breeding successfully, and (4) contributing genes to future generations (Breitenmoser *et al.*

1993, p. 552). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. The available science suggests that landscape-level hare densities consistently >= 0.5 hares/ha (0.2/ac) and favorable snow depth and conditions for about 4 months are needed to support lynx occupancy, reproduction, and recruitment. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or to do so inconsistently.

2.2.2 Ecological Requirements of Populations and the DPS

Lynx populations require essentially the same things that individual lynx do (see Figure 5 and section 2.2.1, above), but on a larger landscape with hare densities and habitat conditions capable of consistently supporting multiple home ranges, breeding and dispersal opportunities, and reproductive and survival rates such that recruitment and immigration will, on average over the long term, equal or exceed mortality and emigration (Pulliam 1988, pp. 652-654). To support persistent lynx populations, such landscapes must provide for the survival of at least some resident lynx even when hares are least abundant and/or other habitat features (e.g., snow conditions) are least favorable so that the population can recover, perhaps aided by immigration, when hare numbers and/or other habitat conditions recover or improve. As with individual lynx, populations are more likely to persist in landscapes where the effects of competition, predation, and human-caused mortality (e.g., trapping, vehicle collisions) are relatively lower.

In a mainland-island metapopulation structure like that thought to govern lynx population dynamics, the persistence of peripheral island populations is determined by colonization and extinction rates (McKelvey *et al.* 2000b, p. 25). Colonization is driven by the number of islands, the distances between them, and the species' dispersal capabilities and timing. Extinction rates are determined by population size and demographic and environmental stochasticity, with extinction more likely in smaller and more isolated populations (McKelvey *et al.* 2000b, pp. 25-31). Lynx populations in the DPS are at the periphery of the species' range and may behave as islands in a mainland-island metapopulation construct. In such a system, larger islands with higher habitat quality and in closer proximity to the mainland would be more likely to support persistent resident populations and to sometimes act as "sources" that produce surplus animals that may disperse to other islands. Smaller islands with lower habitat quality or at greater distance from the mainland may, in contrast, act as "sinks" that depend on immigration from source populations (McKelvey *et al.* 2000b, p. 30), and which may support resident lynx only occasionally, intermittently, or temporarily.

Formal population viability analyses (PVAs) have not been published for lynx populations in the DPS and may not be possible given limited data and natural temporal variation in demographic rates (McKelvey *et al.* 2000a, pp. 22, 30). Although some demographic data are available for most lynx populations in the DPS, most are limited to relatively few, small study areas or relatively short durations. There remains uncertainty about whether, and if so to what extent, the demographic health of DPS populations relies on immigration from northern (Canadian)

populations; and immigration rates are not known for DPS populations (McKelvey *et al.* 2000a, pp. 24-34). These factors likely preclude development of meaningful DPS-wide or unit-specific empirical population viability models (McKelvey *et al.* 2000b, p. 22).

Slough and Mowat (1996, p. 952, Table 4) calculated population growth rate (lambda, λ) = 2.03 (annual doubling) during the 4-year increase-to-peak phase for a lynx population in the core of the species' range in southern Yukon. This period of rapid growth was followed by a rate of λ = 1.01 (stable) during the first year of a hare decline, and λ = 0.10 and λ = 0.46 (rapid decline) during the first two years of the lynx population decline when hares were scarce. (Note – the value λ = 0.01 presented in Slough and Mowat (1996, p. 952, Table 4) appears to be an error; the correct value for λ in a population in which the estimated number of individuals declined from 135 in 1992 to 13 in 1993 should be 13/135 = 0.10 [as presented above]). However, the natural range in λ that would be expected among peripheral, isolated, or semi-isolated lynx populations where hares are non-cyclic or weakly-cyclic (i.e., in DPS populations), versus those that would signal long-term population decline or instability is unknown. Despite this, and the limitations noted above, Squires (*unpubl. data in* Lynx SSA Team 2016, p. 20) calculated population growth rates in northwestern Montana of λ = 0.92 for lynx in the Seeley Lake area (i.e., declining population trend, 1999-2007) and λ = 1.16 for lynx in the Purcell Mountains (increasing trend, 2003-2007). Likewise, McCollough (2016 *unpubl. data*; USFWS, Vortex10, deterministic population simulation) used demographic data from Vashon *et al.* 2012 (pp. 17-21) to calculate finite growth rates during a period of high hare density (λ = 1.16; increasing trend) and during a period of low hare density (λ = 0.88; decreasing trend) for the lynx population in northern Maine (see also section 4.1.1, below).

Although minimum viable population sizes have not been derived for lynx populations in the DPS, the Service's Recovery Outline (USFWS 2005, p. 5) suggested landscapes of at least 1,250 km^2 (483 mi^2) with sufficient boreal/subalpine habitat, hare densities (at least 0.5 hares/ha [0.2/ac]), and snow conditions favorable for lynx ("fluffy and/or deep...for sufficient periods to favor the competitive advantage of lynx"). These are the minimum landscape size and habitat conditions thought necessary to support a minimum lynx population of at least 25 adults based on a lynx density of one lynx per 50 square kilometers (USFWS 2005, p. 5). McKelvey *et al.* (2000b, p. 29) noted that extinction (extirpation) risk should decrease with increasing population size, and that extinction resulting from demographic stochasticity is very unlikely even for a population (generally; not specific to lynx) with as few as 20 reproducing females. Kramer-Schadt *et al.* (2005, entire) developed a spatially explicit population model for Eurasian lynx in Germany which they combined with demographic scenarios to evaluate the likely success of potential reintroduction efforts; they concluded that at least 10 females and 5 males would be required to establish a population with an extinction probability less than 5 percent over 50 years. Rodriguez and Delibes (2003, entire) evaluated extinction among populations of Iberian lynx; they found that extinction occurred only in small populations that occupied habitats of less than 500 km^2 and that extinction within 35 years was unlikely among populations occupying areas of at least 500 km^2 of adequate habitat quality.

In summary, lynx populations need large boreal forest landscapes with snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. These landscapes must have hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term. Immigration may be particularly important to the persistence and stability of lynx populations at the southern periphery of the range, including those within the DPS, where hare densities are generally low and hare populations are either non-cyclic or weakly-cyclic compared to northern populations. Low hare densities reduce the likelihood that lynx recruitment will consistently equal or exceed mortality, and non-cyclic or weakly-cyclic hare populations are unlikely to allow the rapid lynx population recovery observed in northern lynx populations when hare numbers increase dramatically after cyclic population crashes. Although immigration rates for DPS populations are unknown, as is the rate and periodicity of immigration needed to provide demographic stability among them, connectivity with and immigration from lynx populations in Canada is believed to be important to the persistence of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789).

2.3 Historic and Current Lynx Distribution

2.3.1 Lynx Distribution and Status in Canada and Alaska

The Canada lynx is broadly distributed across northern North America from eastern Canada to Alaska (McCord and Cardoza 1982, p. 729; Poole 2003, p. 361; Vashon 2015, p. 4; Alaska Center for Conservation Science 2016, p. 1). It is strongly associated with the expansive, continuous boreal forests of those areas, and its range largely overlaps that of its primary prey, the snowshoe hare, also a boreal forest specialist (Bittner and Rongstad 1982, p. 146; Mowat *et al.* 2000, pp. 268-269; Aubry *et al.* 2000, p. 375). In Canada, lynx are thought to occupy about 5.5 million km^2 (over 2.1 million mi^2), which represents 95 percent of their historic range in that country (Environment Canada 2014, p. 2), and over 89 percent of the species' entire distribution. Nationally in Canada, lynx are classified as secure, widespread, and abundant; they are managed for long-term population stability, with a conservative estimate of 110,000 individuals during cyclic lows; and no acute, widespread threats to lynx have been identified (Environment Canada 2014, entire; Vashon 2015, pp. 1-6). Provincially, lynx status is considered secure in British Columbia, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Northwest Territories, and the Yukon; sensitive in Alberta and Saskatchewan; at risk/endangered in New Brunswick and Nova Scotia; and undetermined in Nunavut (Environment Canada 2014, pp. 3-4; Vashon 2015, p. 1). Lynx were extirpated from Prince Edward Island (0.1 percent of lynx range in Canada) by the late 1800s, and on the mainland the southern margin of assumed lynx range has contracted northward in Quebec, southeastern

Ontario, Manitoba, Saskatchewan, and Alberta (Poole 2003, p. 361; Bayne *et al.* 2008, pp. 1192-1195; Koen *et al.* 2014, pp. 757-760).

In Alaska, lynx are distributed across roughly 534,454 km^2 (206,354 mi^2) of boreal forest habitats (University of Alaska Center for Science Conservation, http://akgap.uaa.alaska.edu/species-data/canadian-lynx-annual-distribution/#content, accessed 4/28/2016; Reimer 2016, pers. comm.), which represents about 8.7 percent of the species' distribution. Lynx in Alaska are apparently secure, with low to moderate threats, and populations appear stable statewide, although total abundance is unknown (Alaska Natural Heritage Program 2008, pp. 2-4). In both Alaska and Canada, lynx trapping is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Alaska Natural Heritage Program 2008, pp. 2-6; Vashon 2015, pp. 5-6). Along the Canada-U.S. border in provinces adjacent to DPS lynx populations, lynx trapping is prohibited in New Brunswick (adjacent to northeastern Maine) but regulated trapping is permitted in Quebec (adjacent to northwestern Maine, northern New Hampshire, and northern Vermont), Ontario (adjacent to northeastern Minnesota), Alberta (adjacent to northwestern Montana), and British Columbia (adjacent to northwestern Montana, northern Idaho, and northern Washington).

2.3.2 Lynx Distribution in the Contiguous United States

2.3.2.1 Defining Lynx Distribution at the Periphery of the Range

Several aspects of lynx population dynamics and dispersal patterns have resulted in inconsistent approaches and difficulty in defining the range and/or distribution of the species, especially at the margins (74 FR 66942). These, combined with uncertainty and ambiguity in the historical record of lynx occurrence, with early assessments based largely on trapping harvest records of questionable accuracy, particularly where lynx and bobcats overlap, and a reliance on anecdotal or unverified occurrence information (McKelvey *et al.* 2000a, pp. 208-210; 65 FR 16054), confound efforts to accurately portray the species' historical distribution in the contiguous U.S. and to assess the current distribution relative to historic conditions (79 FR 54814-54815; McKelvey *in* Lynx SSA Team 2016, p.11). They also have resulted in inaccurate portrayals of lynx distribution and misperceptions that the historic range of lynx in the contiguous U.S. was once much more extensive than is ecologically possible (68 FR 40080; 74 FR 66942).

The range of the lynx must be considered differently from those of other species that are less mobile and have more stable population dynamics. Because the lynx is highly mobile and has cyclic population dynamics that are tied to cyclic snowshoe hare populations, numbers of lynx naturally fluctuate and become extremely low at times during a cycle. Additionally, where snowshoe hare populations are not adequate, resident lynx populations cannot be sustained. Because of this, resident lynx populations never occurred everywhere boreal forest existed in the contiguous U.S. Where the boreal forest was naturally more patchy and marginal, the habitat was incapable of supporting an adequate snowshoe hare population that in turn was incapable of supporting a resident lynx population over time. As a result, only a few areas in the

contiguous U.S. historically supported an adequate quantity and quality of habitat to support resident lynx populations over time, and many historical lynx occurrences across a large area of the contiguous U.S. were likely dispersers. The occurrence of dispersing lynx is unpredictable, and dispersing lynx will likely continue to periodically move into areas that are not lynx habitat (68 FR 40077).

The dramatic, cyclic fluctuations in lynx populations across much of the range as they track cyclic hare populations and the mass synchronous dispersals (irruptions) of large numbers of lynx into the contiguous U.S. when northern hare populations crashed are well-documented (Elton and Nicholson 1942, entire; Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 219, 232-242; Mowat *et al.* 2000, pp. 281-294; ILBT 2013, p. 33). These events have resulted in records of lynx occurrence, in some cases very rarely, in others sometimes in large numbers and with intermittent (cyclic) regularity, in places that otherwise lack evidence of persistent lynx presence or the habitats and hare densities necessary to support a resident lynx population (U.S. Fish and Wildlife Service 2005, pp. 3-4; 79 FR 54787-54789, 54793-54795, 54812-54823). Many records of lynx in the contiguous U.S. appear to be related to such events, including the unprecedented ‘‘explosions’’ of lynx observed in the early 1960s and 1970s (Gunderson 1978, entire; McKelvey *et al.* 2000a, pp. 232-242). During these events, many lynx occurred in anomalous habitats, exhibited unusual behavior, suffered high mortality, and numbers declined dramatically within a few years of irruptive peaks (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, p. 242). Because dispersing lynx typically do not persist in these areas of temporary range expansion, disappearing fairly quickly after irruptions, van Zyll de Jong (1971, p. 16), suggested that only areas that support lynx populations throughout both the low and the high phases of the “10-year cycle” (i.e., across the natural range of hare densities) should be considered to constitute the species’ range. In its 2003 remanded determination, the Service determined that lynx in the contiguous U.S.exist either as resident populations or as dispersers, that dispersing lynx are often found repeatedly and for variable amounts of time in habitats that cannot sustain breeding populations over time (though some breeding may occur occasionally in some of these areas), and that such areas probably contribute little to the persistence of lynx in the DPS (68 FR 40077, 40079-80). This repeated dispersal into habitats that ultimately cannot support the species (‘‘sink’’ habitats) often leads to confusion among scientists and the public about where lynx populations may be viable (74 FR 66938).

In addition to distinguishing between historical occurrence records associated with irruptions/ dispersal and those suggesting resident lynx populations, the “mainland-island” metapopulation structure thought to govern lynx populations in the DPS (McKelvey *et al.* 2000b, pp. 25-31; see Section 2.2, above) and the transitional (and, therefore, increasingly fragmented and isolated) and spatially- and temporally-shifting nature of lynx habitat at the southern periphery of the range (Koehler and Aubry 1994, pp. 78-79; McKelvey *et al.* 2000b, pp. 29-30; 74 FR 66940; 79 FR 54814) also present challenges in defining the distribution of lynx. Both factors suggest that some areas of the contiguous U.S. may naturally support resident lynx only temporarily or occasionally when habitat conditions (both boreal forest vegetation supporting abundant hares and snow conditions favoring lynx) are adequate and/or when immigration is sufficient to offset

the lower productivity and recruitment rates expected among lynx populations in marginal or suboptimal habitats. McKelvey *et al.* (2000b, pp. 21, 29-31) described such habitats as "... source-sink mosaics that shift with disturbance and succession," and the contribution, if any, of these places (especially those that act more often as "sinks" than "sources") to the maintenance and persistence of lynx populations in the DPS remains questionable (74 FR 66938).

Finally, the southern periphery of the lynx's range, where lynx are rare in many places, overlaps with the northern distribution of the much more common bobcat; the two species are difficult to distinguish in the field, they often were not reliably differentiated in historical trapping records (McKelvey *et al.* 2000a, pp. 208-209), and errors in early accounts of lynx distribution based on anecdotal information seem likely (Halfpenny and Miller 1980, pp. 1, 3-8; Meaney 2002, pp. 3-5, Hoving *et al.* 2003, pp. 366-367; Krohn 2010, p. 33). Because of the large effect that relatively few errors in identification can have on assessments of the distribution of rare animals, especially those that are easily confused with a similar and more common species, McKelvey *et al.* (2000a, p. 209; 2008, pp. 553-554) suggest that anecdotal information should be interpreted with caution, and only verified occurrence data should be used to assess historical and current lynx distributions.

These complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with a naturally dynamic and transitional habitat, make it difficult, if not impossible, to precisely delineate the historic or current distribution of resident lynx populations in the contiguous U.S. (Koehler and Aubry 1994, p. 79; 68 FR 40084). While recognizing these limitations, we use our best professional judgment of the best scientific and commercial data available to make conclusions about the range of the lynx for the purposes of this SSA. In the following section, we describe the types and distributions of potential lynx habitats in the contiguous U.S., and our current understanding of the historical and current distributions of resident lynx populations in the DPS considering the factors discussed above.

2.3.2.2 Lynx Distribution within the DPS Range

The southern periphery of boreal forest vegetation extends into parts of the northern contiguous U.S., where it transitions to the Acadian forest in the Northeast (Seymour and Hunter 1992, pp. 1, 3), deciduous temperate forest in the Great Lakes regions, and subalpine forest in the Rocky Mountains and Cascade Mountains in the west (Agee 2000, pp. 40-41). In much of the DPS range, these boreal forest landscapes become naturally patchy and transitional because they are at the southern edge of the boreal forest range, and they are limited, particularly in the west, by elevation and/or aspect (Ruediger *et al.* 2000, p. 4-16; 68 FR 40090). There also is increased prevalence of non-forested land uses (e.g., agriculture, development) at the southern periphery of boreal forests. These factors generally limit snowshoe hare populations in the contiguous U.S. from achieving landscape densities similar to those of the expansive northern boreal forest in Alaska and Canada, where hares are generally more abundant and more evenly distributed across the landscape (Wolff 1980, pp. 123-128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373-375, 382, 394). Consequently, important foraging habitat for lynx is often more limited and fragmented in the

contiguous U.S. than in boreal forests of northern Canada and Alaska (Berg and Inman 2010, p. 6), and overall habitat quality is typically lower.

The habitats that lynx use in the contiguous U.S. are characterized by patchily-distributed moist forest types with relatively higher hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with lower landscape hare densities (ILBT 2013, p.126; 78 FR 59434). In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support higher hare densities where most lynx foraging occurs. In some areas, patches of habitat containing snowshoe hares become so small and fragmented that the landscape cannot support lynx home ranges (ILBT 2013, p. 77) or populations over time (68 FR 40077). Additionally, the presence of more snowshoe hare predators and competitors at southern latitudes may inhibit the potential for high-density hare populations (Wolff 1980, p. 128). As a result, lynx generally occur at relatively low densities in the contiguous U.S. compared to the high lynx densities that occur in the boreal forest of Canada when hares are abundant (Aubry *et al.* 2000, pp. 375, 393-394) or the densities of species such as the bobcat, which is a habitat and prey generalist.

Snow conditions also determine the distribution of lynx (Ruggiero *et al.* 2000b, pp. 445-449), which are morphologically and physiologically adapted for hunting snowshoe hares and surviving in areas that have cold winters with deep, fluffy snow for extended periods. These adaptations provide lynx a competitive advantage over potential competitors, such as bobcats or coyotes (McCord and Cardoza 1982, p. 748; Buskirk *et al.* 2000a, pp. 86-95; Ruediger *et al.* 2000, pp. 1-11; Ruggiero *et al.* 2000b, pp. 445, 450), which have a higher foot load (more weight per surface area of foot), causing them to sink into the snow more than lynx. Therefore, bobcats and coyotes cannot hunt efficiently in fluffy or deep snow and are at a competitive disadvantage to lynx. Long-term snow conditions presumably limit the winter distribution of potential lynx competitors such as bobcats (McCord and Cardoza 1982, p. 748) or coyotes. These adaptations may also help lynx avoid predators such as mountain lions (Squires and Laurion 2000, p. 346), which also have higher foot-loading (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, p. 123), making them less efficient in deep and fluffy snow conditions.

Based on verified historical data, lynx occurrence has been documented in 24 states in the contiguous U.S. (McKelvey *et al.* 2000a, 207-232) and, more recently, in a 25th after some of the lynx released into southwestern Colorado dispersed into northern New Mexico (Colorado Division of Wildlife 2000, p. 3; 74 FR 66938), which had previously lacked verified evidence of lynx occurrence (USFS 2009, entire; 74 FR 66940-66943). Of these, and based on our current understanding of lynx and hare habitat requirements, the Service concludes that records in at least 11 states (Connecticut, Illinois, Indiana, Iowa, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Pennsylvania, and South Dakota) most likely represent occasional dispersing lynx that arrived in places with no historic or recent evidence of the habitat quality or quantity necessary to support a persistent resident lynx population (68 FR 40099; 74 FR 66940-66942; 79 FR 54807, 54817). These states are not within the distribution of resident lynx in the DPS, and we conclude that they naturally lack the necessary habitat, hare densities, and snow

conditions and that they were not capable historically and are not capable now of supporting resident lynx populations.

The Service originally identified the DPS as occurring in forested portions of the remaining 14 states (Colorado, Idaho, Maine, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming; 65 FR 16052, 16085). Some of these states, and parts of others, are thought to have historically supported only dispersing lynx or to have only occasionally supported resident breeding lynx (68 FR 40099; 74 FR 66940). Such areas were included within the range of the DPS because of the possibility that lynx could establish small, local populations in them and perhaps contribute to the persistence of the DPS, though evidence of this was lacking (68 FR 40080; 74 FR 66938). In its 2003 remanded determination for the lynx DPS, the Service concluded that (1) potential lynx and hare habitats in Michigan, Oregon, Utah, Vermont, and Wisconsin were relatively small, isolated, and of marginal quality, and that available information suggested that these states did not historically or recently support resident lynx populations; (2) it was uncertain whether Colorado, New York, and Wyoming historically supported resident populations or only occasional dispersers; (3) New Hampshire probably supported a small resident populations that had been extirpated; and (4) the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) had the best historic and recent evidence of resident breeding populations (68 FR 40082, 40086-40095, 40097-40101). Below we provide our current understanding of these state groupings and the information available since the 2003 remand that informs this understanding.

Michigan, Oregon, Utah, Vermont, and Wisconsin - Additional information and analysis available since 2003 support the determination that Michigan (Linden 2006, pp. 83-90) and Oregon (Aubry 2006, pp. 1-2) did not historically or recently support resident lynx populations, and no evidence has emerged suggesting that resident populations occurred historically or recently in Utah or Wisconsin (ILBT 2013, pp. 45, 58). The best available information continues to suggest that resident lynx did not historically and do not currently occur in Michigan, Oregon, Utah, and Wisconsin; that habitats in these states are naturally incapable of supporting resident breeding populations; and that historic and potential future occurrences of lynx in these states most likely represent occasional dispersing lynx. We conclude, therefore, that these states did not historically, do not currently, and in the future are very unlikely to, contribute to the persistence and conservation of lynx in the contiguous U.S.

In contrast, nine lynx occurrences were confirmed in the 530-km^2 (205-mi^2) Nulhegan Basin of northeastern Vermont from 2003 to 2014, and breeding was confirmed in 2012; intensified surveys since then have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). This new information indicates that this small area of northernmost Vermont is at least occasionally capable of supporting a small number of resident breeding lynx, but that its ability to support a persistent resident population over time remains doubtful. Based on assessments of the amount and quality of potential lynx and hare habitat, snow conditions, and the presence and distribution of lynx competitors and predators (Hoving *et al.* 2005, pp. 746-749; Bernier 2015, entire), we conclude it is unlikely that northern Vermont can support a persistent resident lynx population (79 FR 54820-54821); that it only occasionally

supports lynx reproduction when hare abundance and snow conditions are temporarily adequate; that it most likely represents a “sink” rather than a “source” for the regional lynx population, and that this likely represents its natural historical condition.

Colorado, New York, and Wyoming - When the Service listed the DPS in 2000, it believed that a resident lynx population occurred historically in the Southern Rocky Mountains of western Colorado and southeastern Wyoming, that lynx were also historically resident in northwestern Wyoming (part of the Northern Rocky Mountains), and that the Adirondack Mountains of northern New York may historically have supported a resident population that was by then extirpated (65 FR 16055-16056; 16058-16059). In the 2003 remand, the Service noted inconsistencies and likely errors in historic lynx reports for the Southern Rockies, questioned its original conclusion that Colorado historically supported an isolated resident population, and concluded that it was uncertain whether a resident population occurred historically in Colorado or if historic records were of periodic dispersing lynx during “extremely high populations cycles” and that a resident population never existed in southeastern Wyoming (68 FR 40081, 40091). The Service also noted that in 1999 and 2000 the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) introduced 96 lynx from Canada and Alaska into southwestern Colorado (with plans to release an additional 186 lynx from 2003-2009) in an effort to reestablish a resident lynx population, that reproduction among some of the released lynx had been documented by 2003, but that it was too early to determine whether the program would be successful (68 FR 40091). In that rule, the Service also concluded that, despite evidence of reproduction in northwestern Wyoming (part of the GYA), potential habitat there is naturally marginal (patchier and composed of drier forest types), may be incapable of supporting a resident lynx population, and that lynx in northern Wyoming are most likely dispersers (68 FR 40090). Also in 2003, the Service concluded that it was possible resident lynx occurred in northern New York prior to 1900 but the potential habitat there is small, marginal, and likely has only supported dispersing lynx since then, and that an effort to reintroduce lynx there failed quickly, suggesting the habitat is incapable of supporting a resident population (68 FR 44486-44487).

In Colorado, after the initial release of 96 lynx in 1999 and 2000, none were released in 2001 or 2002 while protocols were evaluated and refined based on monitoring of the initially-released lynx (Shenk 2010, pp. 1, 4; Ivan *in* Lynx SSA Team 2016, p. 22). From 2003-2006, another 122 lynx were released, bringing the total to 218 (Devineau *et al.* 2010, p. 526). Reproduction was documented in 2003-2006 and 2009-2010, with 48 dens documented in that time, including a third generation of Colorado-born lynx (Shenk 2010, p. 5; Ivan *in* Lynx SSA Team 2016, p. 22). In 2010, CPW determined that all benchmarks for its lynx program had been met and had resulted in the establishment of a viable, self-sustaining lynx population (Ivan, 2011a, pp. 11, 12). Intensive monitoring of the population ceased in 2010 and was replaced by an effort to develop a minimally-invasive long-term monitoring program (Ivan 2011b, entire), which used snow-tracking surveys and camera traps to document continued lynx presence in the core release area of the San Juan Mountains in 2010-11 and again in 2014-15, with evidence of reproduction also documented during that time (CPW 2015, p.1; Ivan *in* Lynx SSA Team 2016, pp. 22-23). In its 2014 revised critical habitat designation for the DPS, the Service concluded

that the historic record of verified lynx occurrence in Colorado combined with naturally highly-fragmented and isolated potential habitat and generally low snowshoe hare densities suggest that Colorado and the Southern Rockies were unlikely to have historically supported a persistent resident lynx population and that the long-term persistence of the introduced population is uncertain (79 FR 54787-54789, 54793-54795, 54816-54817). The current size of the resident lynx population in Colorado is unknown but thought to number between 100 and 250 (Ivan *in* Lynx SSA Team 2016, p. 47). We continue to believe that available information suggests Colorado did not historically support a persistent resident lynx population and that the long-term persistence of the introduced population remains uncertain.

Information and analyses since the 2003 remand support the conclusion that New York has inadequate habitat quantity and quality (both vegetation and snow conditions) to support a resident lynx population (Hoving *et al.* 2005, pp. 746, 749). Based on Hoving *et al.* (2005) and our evaluation of the verified records of historic occurrence presented by McKelvey *et al.* (2000a, pp. 215-217), we conclude that the Adirondack Mountains of northern New York have not recently and likely did not historically support a persistent resident lynx population, are likely incapable of doing so, that verified historic records were most likely of dispersing lynx, and dispersing lynx may currently and in the future continue to occur rarely and temporarily in northern New York.

In northwestern Wyoming, additional information available since 2003 documented continued presence of a small number of lynx as recently as 2010, including some evidence of reproduction during that time, and documentation of Colorado-released lynx that dispersed into and through Wyoming (Squires *et al.* 2003, entire; Squires and Oakleaf 2005, entire; Murphy *et al.* 2006, entire; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Hanvey 2016, pers. comm.; Ivan 2016, pers. comm.; Murphy 2016, pers. comm.). However, more recent surveys and research-related trapping efforts have failed to detect lynx in this area or elsewhere in Wyoming since 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45). In the 2014 revised critical habitat designation, the Service noted:

> Although the GYA has a long history of lynx presence and recent evidence of reproduction (Squires and Laurion 2000, entire; Squires *et al.* 2001, entire; Murphy *et al.* 2006, entire), there are relatively few verified records of lynx from Yellowstone National Park and surrounding areas (65 FR 16058, 68 FR 40090). Additionally, lynx habitat in the GYA is naturally marginal (patchier and composed in many places of drier forest types), less capable of supporting snowshoe hares (Hodges *et al.* 2009, entire), and farther from source populations than most other parts of the DPS range (68 FR 40090). Given the naturally marginal habitat in this largely protected area, we believe it is unlikely that the GYA ever supported more than a handful of lynx home ranges in any given year. We find no evidence that the GYA once supported a larger or more robust lynx population than the small one suggested by verified historic and recent records and survey efforts (79 FR 54791).

We concluded that the historic record and recent evidence of lynx occupancy and reproduction suggested the presence of a small but persistent resident lynx population in the GYA of northwestern Wyoming and southwestern Montana (79 FR 54791, 54796-54797, 54825-54826); however, the consistency of occupancy over time remains uncertain (Lynx SSA Team 2016, pp. 11, 45, 57). Uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016, p. 57). If residency was intermittent historically, the current apparent absence of resident lynx might be a natural condition related to the area's largely marginal or suboptimal habitat conditions - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. In that case, future intermittent residency would be expected, but only if lynx dispersing from a source population immigrate to the GYA when habitat conditions and hare densities return to more favorable levels. Conversely, if the GYA always historically supported a small number of resident lynx but no longer does, it may suggest that some factor or factors have acted to tip the quality of the area's habitat from just barely capable of supporting a small resident population to no longer capable of doing so, resulting in extirpation. We conclude that this uncertainty cannot be resolved based on the available information but, given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its historic inability to support a robust, persistent resident population and its apparent recent inability to support any resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. We also note that extensive areas of the GYA were burned by the large, intense wildfires of 1988, and that these areas may soon (perhaps in the next 5-15 years) regenerate to a stage containing the dense horizontal conifer structure favorable for hares and, therefore, lynx foraging habitat, perhaps increasing the likelihood that the GYA may support resident lynx again in the near future (Lynx SSA Team 2016, p. 46).

In southern Wyoming, all recent occurrences of lynx appear to be of Colorado-released lynx that moved into or through the area (see Devineau *et al.* 2010, Fig. 1, p. 526), including one female who in 2004 established a den in the Snowy Mountains and produced kittens that did not survive (Bjornlie 2016, pers, comm.; Ivan 2016, pers. comm.). Based on the available information, we conclude that southern Wyoming did not historically or recently support a resident lynx population and is not now capable of doing so.

New Hampshire - There were 18 confirmed lynx records indicating 28 individual lynx in northern New Hampshire from 2006 to 2013, with evidence of reproduction in 2010 and 2011 (79 FR 54820). An additional 8 lynx detections were documented in 2014 (Siren 2014, p. 7), 24 lynx track intercepts were recorded during snow-tracking surveys during the winter of 2014-2015 (Siren 2016, p. 1), and surveys in 2016 also detected lynx (Siren 2016, pers. comm.). Most records since 2006 are in the vicinity of Pittsburg in the northernmost reaches of the state, though lynx detections in 2015 and 2016 suggest a southern expansion from the area of 2006-2014 detections (Siren 2016, p. 1; Siren 2016, pers. comm.). Despite recent evidence of lynx

residency and reproduction, the Service concluded in the 2014 revised critical habitat designation that, based on modeling of the amount of potentially suitable habitat and favorable snow conditions (Hoving *et al.* 2005, pp. 739, 749; Litvaitis and Tash 2005, p. A-298), it is unlikely that northern New Hampshire will support a resident breeding population over the long-term (79 FR 54820-54821). Siren (2014, p. 10) suspected that the relatively few lynx detections documented in 2012-2014 may be related to the presence and abundance of bobcat, coyote, and fisher populations in northern New Hampshire. We conclude that northern and central New Hampshire likely supported a small resident lynx population historically that was extirpated during the latter half of the 20th century. We are uncertain whether lynx detections in northernmost New Hampshire over the past decade may represent the natural reestablishment of a small resident breeding population in the state or if it is a temporary phenomenon related to an expanding source population in neighboring northern Maine (79 FR 54821). Although bobcat populations have increased and expanded their range in this region in recent decades (Lavoie *et al.* 2009, pp. 873-874), severe winters and deep snow can substantially limit their populations (Reed 2009, pp. 29-33; McCord, 1974, pp. 433-434). Maine's bobcat harvest declined substantially after two deep snow winters in 2008 and 2009 (Maine Department of Inland Fisheries and Wildlife 2015, p. 37). It is possible that these anomalous deep snow winters provided a temporary competitive advantage to lynx in northern New Hampshire.

Idaho, Maine, Minnesota, Montana, and Washington - These states (along with New Hampshire, above) have the strongest historical evidence of continuous lynx presence and recent evidence of resident lynx populations (McKelvey *et al.* 2000a, pp. 211-228; 68 FR 40086-40095, 40097-40101; McKelvey *in* Lynx SSA Team 2016, p. 11). Historic lynx records exist for much of Idaho, but many, especially in the central and southern part of the state, occurred in anomalous habitats or were associated with large irruptions of lynx from Canada to the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 225-227). The historic record and recent surveys (summarized at 79 FR 54818-54820; also see U.S. District Court ID 2016, pp. 18-24) suggest that only dispersing lynx occur throughout most of Idaho, habitats in many parts of the state are drier forest types that support lower densities of hares, and resident lynx seem to be confined to the Purcell, Selkirk, and possibly the Cabinet mountain ranges in the northern panhandle. The number of resident lynx in northern Idaho is unknown but certainly small based on the amount of potential habitat, and resident lynx here are part of a larger population that occurs primarily in northwestern Montana and southeastern British Columbia.

Maine has a long history of continual lynx presence, with evidence of a persistent resident population in much of the northern half of the state, which currently supports the largest lynx population in the DPS (Krohn 2010, entire; McKelvey *et al.* 2000a, pp. 211-212; Hoving *et al.* 2003, entire; Vashon *et al.* 2012, pp. 50-60; 79 FR 54784-54785, 54792, 54822-54824; Vashon *in* Lynx SSA Team 2016, p. 18). The lynx population in Maine is much larger than was suspected at the time of listing or the 2003 remand (potential habitat exists to support possibly 750-1,000+ individuals [Vashon *in* Lynx SSA Team 2016, p. 18], though a reliable population estimate is lacking). The current abundance of lynx is supported by the broad distribution of high-quality hare habitat that resulted from extensive, large-scale clearcutting in the 1970s and

1980s in response to a massive spruce budworm outbreak (68 FR 40087; 79 FR 54792; also see section 4.1.1, below). As these regenerating clearcuts, which currently provide the dense horizontal structure preferred by hares, mature beyond about 35 years post-harvest, hare densities decline as cover and forage are reduced due to forest succession (Simons 2009, p. 217). The current lynx population is probably larger than the likely historic condition, when relatively small amounts of the spruce-fir forests in the state are thought to have been composed of young stands (Lorimer 1977, entire; 68 FR 40094; Vashon *et al.* 2012, pp. 45, 56; 79 FR 54792). With the reduction in clearcutting following enactment of the Maine Forest Practices Act of 1989, it is projected that lynx densities in Maine will decline by 55 to 65 percent by 2032 (Simons 2009, p. 217). Lynx in Maine likely represent the southern periphery of a larger population that occurs in northern New Brunswick and southern Quebec south of the St. Lawrence Seaway/River, which appears to partially isolate lynx in this region, demographically and genetically, from populations in the core of the species' range (Koen *et al.* 2015, entire). The extent to which lynx persistence in Maine relies on immigration from Canada is unknown.

In Minnesota, research conducted since the 2003 remand has demonstrated the continuous presence of a resident lynx population in the northeastern part of the state that seems to be the southern periphery of a larger population in southwestern Ontario (Moen *in* Lynx SSA Team 2016, pp. 19, 39). The number of resident lynx in Minnesota is unknown but believed to be between 50 and 200 (Moen *in* Lynx SSA Team 2016, pp. 19, 39). Lynx are occasionally detected in other parts of the state, but hare densities and snow conditions consistently favorable for lynx appear to be restricted to the northeastern "Arrowhead" region of the state, and areas to the south and west are dominated by bobcats. Although there are currently more lynx in Minnesota than suspected at the time of listing, it is unclear whether current numbers and distribution are similar to the historical condition. The extent to which lynx persistence in Minnesota relies on immigration from Canada is also unknown.

In Montana, research conducted since the DPS was proposed for listing has documented the continued presence and broad distribution of resident lynx in much of the northwestern portion of the state (Squires *in* Lynx SSA Team 2016, p. 20). The number of resident lynx in northwest Montana is unknown but believed to be between 200 and 300 (Squires *in* Lynx SSA Team 2016, p. 41) in three subpopulations - the Purcell Mountains, Seeley Lake/Central, and Garnet Mountains subpopulations (Squires *in* Lynx SSA Team 2016, p. 20). Recent (2014-2015) surveys failed to detect lynx in the Garnet Mountains in the southern part of the area (Squires *in* Lynx SSA Team 2016, p. 20), which had residents as recently as 2010 and is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.). Lynx in northwestern Montana (and northern Idaho) likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia. The extent to which lynx persistence in this area relies on immigration from Canada is unknown, and there is no indication of substantial immigration from Canada after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). In southwest Montana, few lynx and no recent evidence of reproduction have been documented in the Montana portion of the GYA where, as with the northwestern Wyoming part of the GYA (discussed above), uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent

apparent absence from the area (Lynx SSA Team 2016, p. 57). As elsewhere in the West, recent research and habitat assessments suggest that habitats capable of supporting resident lynx in Montana are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12).

In Washington, research and monitoring conducted since the 2003 remand has continued to document a resident lynx population in the Okanogan region of the eastern Cascade Mountains in the north-central part of the state (von Kienast 2003, entire; Maletzke 2004, entire; Koehler *et al.* 2008, entire; Maletzke *et al.* 2008, entire; Maletzke *in* Lynx SSA 2016, pp. 21-22). Since at least 1985, this is the only area of the state with evidence of a resident breeding population (Koehler and Maletzke 2006, p. 4; Koehler *et al.* 2008, p. 1518; ILBT 2013, p. 58; Maletzke *in* Lynx SSA 2016, p. 21), although the Kettle Mountains in the northeastern part of the state are thought to have historically supported a small breeding population, and lynx are detected there occasionally (Stinson 2001, pp. 13–14; Koehler *et al.* 2008, p. 1523; USFWS 2008, p. 2). Multiple large fires in the Okanogan over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). Although these areas should regenerate into lynx and hare habitat, it may take 35-40 years (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and insect impacts could further diminish habitat availability and the lynx population's probability of persistence (Lynx SSA Team 2016, p. 44; see also sections 3.4, 4.1.4, and 5.1.4, below).

In summary, although uncertainty remains regarding the historic distribution of resident lynx in the DPS and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population declines in the contiguous U.S. from historical conditions until the DPS was listed have been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11). New information summarized above indicates that there are many more lynx in Maine and Minnesota than was suspected at the time of listing, and there are naturally fewer lynx and a more limited distribution of suitable habitats in the western U.S. than was previously thought (68 FR 40085, 40091-40092; ILBT 2013, p. 23). Lynx in Maine are at historically high numbers and may currently be facilitating the recolonization of formerly occupied habitat in northern New Hampshire, though lynx persistence in New Hampshire is uncertain and lynx numbers in Maine are projected to decline over the next several decades. In the West, small breeding populations in the GYA and the Garnet Mountains of Montana may recently have become extirpated (although both also may be only temporarily "winked off" in a metapopulation dynamics sense). In north-central Washington, lynx habitat and numbers have declined because of recent large fires and insect outbreaks, and the persistence of the breeding population there could be threatened if additional such impacts occur with similar magnitude and frequency over the next several decades. As a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, resident lynx currently occur in western Colorado. Although the number of lynx in this population and its future persistence are uncertain, Colorado currently

supports more lynx than it likely did, based on the historic record, for much of the previous century. The geographic units evaluated in this SSA include all areas in the contiguous U.S. with strong historical and recent evidence of persistent resident lynx populations. Detailed assessments of the current status and future viability of resident lynx populations and habitats in these areas are presented in chapters 4 and 5 below.

Chapter 3: Factors Influencing Viability of the DPS

In this chapter we discuss factors thought to influence the historic and current distribution and status of lynx populations in the contiguous U.S., their likely influence on the future viability of the DPS, and we describe the cause-and-effects pathways of impacts associated with particular factors. We focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in federal land management plans at the time of listing) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68-78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS.

3.1 Regulatory Mechanisms

A number of activities with the potential to affect lynx habitat suitability, productivity, mortality, and movements via habitat loss or fragmentation, creation of barriers, or that otherwise alter the vegetation mosaics and prey abundances maintained historically by natural disturbance processes may occur in lynx habitats regardless of land ownership and management. The extent to which regulations guide such activities to avoid, minimize, or mitigate impacts to lynx influences the current and future likelihoods that those habitats will provide the physical and biological features needed to support resident lynx populations. As described in more detail below, the lynx DPS was listed as threatened because of the lack of specific conservation direction and associated regulations on federal lands. At that time, the available information indicated that most lynx habitat in the DPS occurred on federal lands, predominantly in the western U.S. (65 FR 16061). Since then, research and monitoring have revealed that non-federal lands contribute more to the conservation of the DPS than was known at the time of listing, particularly in the Northern Maine and Northeastern Minnesota regions. Therefore, in the following sections we describe and compare the federal regulatory environment for lynx in the DPS at the time of listing and currently, and we describe other regulatory mechanisms as they pertain to lynx on private as well as State and Tribal lands.

Since it was listed in 2000, the DPS has been protected by the ESA's prohibition on take (under section 9), which applies to lynx wherever they occur in the DPS, regardless of land ownership. The DPS has also been protected since listing by section 7 of the ESA, which requires federal agencies to use their authorities to conserve listed species and to consult with the Service for any actions they implement, fund, or permit (i.e., for which a "federal nexus" exists) and which

may affect lynx or lynx habitats within the DPS, again regardless of land ownership. Additionally, section 4 of the ESA requires that critical habitat, defined as the specific geographic areas containing the physical and biological features essential for the conservation of a listed species and that may require special management and protection, be designated for listed species, and section 7 prohibits the destruction or adverse modification of such designated habitats. Critical habitat was designated for the lynx DPS in 2007 and was revised in 2009 and 2014. Section 4 also requires recovery planning for listed species; a recovery plan for the lynx DPS has not yet been completed, but part of the purpose of this SSA is to inform near-term recovery planning direction.

3.1.1 Federal Regulatory Mechanisms

Federal lands make up approximately 64 percent of the lands encompassed by the six geographic units evaluated in this SSA. Of those federal lands, roughly 87 percent is managed by the U.S. Forest Service (USFS), 11 percent by the National Park Service (NPS), and 2 percent by the Bureau of Land Management (BLM). The amount of federal land varies by unit, ranging from 0 percent in the Northern Maine Unit to over 97 percent in the GYA Unit (see Table 1, above, and Chapter 4, below, for ownership in each geographic unit). Federal lands management is guided by a number of statutes and associated regulations, policies, standards, guidelines, and best management practices applied by managing agencies to meet legislative mandates and achieve agency missions (for a summary of relevant Acts and associated regulations and guidance, see USFWS 2014, pp. 24-34). Many of these regulatory mechanisms provide some benefits to lynx and protect lynx habitats (USFWS 2014, pp. 24-34). For example, the conservation priority in the management of NPS lands in accordance with the National Park Service Organic Act (16 USC 1 et seq. as amended), the National Parks and Recreation Act (Public Law 95-625), and the Wilderness Act (16 USC 1131-1136, 78 Stat. 890) likely provides an adequate regulatory framework for the conservation of lynx populations and habitats in the NPS units in which they occur (USFWS 2014, pp. 28-29, 31-33). However, it was the absence of specific management direction and conservation measures for lynx and lynx habitats in USFS and BLM land management plans that led the Service to conclude that the regulatory mechanisms in those plans at the time of listing were inadequate to provide for the conservation of the DPS. Therefore, the evaluation below focuses on the efforts of USFS and BLM, in collaboration with the Service, to address the regulatory inadequacy for which the DPS was listed.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx populations and potential lynx habitats (broad forest vegetation classes defined as “lynx forest types” [65 FR 16071]) in the contiguous U.S. occurred on federal (USFS, NPS, and BLM) lands in the western states, and that the plans that guided management of those lands (particularly USFS and BLM lands) included “...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species” (65 FR 16052, 16082). At that

time, the Service found that USFS and BLM management plans did not adequately address risks to lynx and, as identified in the LCAS (Ruediger *et al.* 2000, pp. 2-1 through 6-3), those plans allowed actions that cumulatively could result in significant detrimental effects to lynx in the contiguous U.S. As a result, the Service concluded in the final rule that the lack of federal Land Management Plan guidance for the conservation of lynx and the potential for those plans to allow or direct actions that could adversely affect lynx constituted a significant threat to the DPS (68 FR 40096).

In 1998, in anticipation of the DPS's listing under the ESA, regional and state directors of the Service, USFS, BLM, and NPS approved preparation of the interagency LCAS to provide a consistent and effective approach to conserve lynx and to assist with Section 7 consultation on federal lands. An interagency Steering Committee selected a Science Team to assemble the best available scientific information on lynx and appointed the ILBT to prepare a lynx conservation strategy applicable to federal land management in the contiguous U.S. (USFWS 2014, p. 15). The first edition of the LCAS was completed in January, 2000 and revised in August, 2000 (Ruediger *et al.* 2000, entire). The Steering Committee subsequently issued several amendments and clarifications, and the most recent revision of the LCAS was completed in August, 2013 (ILBT 2013, entire). The LCAS initially identified and evaluated 17 risk factors (e.g., timber and fire management, recreation, roads, livestock grazing, trapping, etc.) thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements, and that may be addressed under programs, practices, and activities within the authority and jurisdiction of federal land management agencies. These risk factors included programs or practices with the potential to result in habitat conversion, habitat fragmentation, or obstruction to lynx movement; roads or winter recreation trails that may facilitate access to historical lynx habitat by competitors; and fire suppression, which changes the vegetation mosaic maintained by natural disturbance processes. The risks identified in the 2000 LCAS were based on potential effects to lynx habitats and to individual lynx, lynx populations, or both; therefore, not all of the risks initially identified in the LCAS were thought to threaten lynx populations in the DPS (68 FR 40096). In the 2013 revised LCAS, risk factors were redefined as "Anthropogenic Influences on Lynx and Lynx Habitat," and grouped into two tiers based on the potential magnitude of effects (ILBT 2013, pp. 1, 68). First tier influences (climate change, vegetation management, wildland fire management, and habitat fragmentation - discussed in the remainder of this chapter, below) are those with potential to negatively affect lynx populations and habitats, while second tier influences are those that may affect individual lynx but are not expected to substantially impact populations or habitats (ILBT 2013, pp. 68-85).

In addition to identifying risks, the LCAS also directed federal agencies to map potential lynx habitat and identify lynx analysis units (LAUs) to evaluate potential impacts of management actions on lynx and snowshoe hare habitats. Finally, the LCAS developed recommended conservation measures, standards, and guidelines to be applied to lynx habitats on federal lands that were designed to mimic historic conditions and landscape-scale disturbance patterns and to maintain or improve lynx and hare habitats at both local (project-level) and landscape scales (USFWS 2014, p. 16). After its initial completion in 2000, USFS and BLM managers within the range of the DPS agreed to implement the standards and guidelines identified in the

LCAS until management plans could be formally amended to specifically address lynx conservation. In 2000, the Service, USFS, and BLM developed and adopted Canada Lynx Conservation Agreements (CAs; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire) in which the BLM and USFS agreed to coordinate assessment and planning efforts with the Service to assure a comprehensive approach to lynx conservation and to use the LCAS, supporting science, and locally specific information as the basis for the approach and to streamline consultation under section 7 of the ESA. The USFS further committed to deferring any actions not involving third parties that would adversely affect lynx until such time as the Forest Plans were amended or revised to adequately conserve lynx (USFS and USFWS 2000, p. 8; 68 FR 40083).

Concurrent with development of the LCAS and interagency CAs, the USFS and BLM in 1999 completed the *Biological Assessment* (BA) *of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx* (USFS and BLM 1999, entire). The BA identified and evaluated the potential effects to lynx of implementation of 57 USFS Land and Resource Management Plans and 56 BLM Land Use Plans throughout the 14 states in which the lynx DPS was proposed for listing. The BA concluded that the potential for adverse effects to lynx existed on each administrative unit in each geographic area and that, cumulatively, implementation of the existing plans was likely to adversely affect the DPS. It recommended that all of the plans be amended or revised to incorporate conservation measures to reduce or eliminate adverse effects to lynx (USFS and BLM 1999, p. 14). In its 2000 biological opinion on the BA, the Service evaluated the USFS and BLM plans in conjunction with the CAs described above (USFWS 2000, p. 15). The Service concluded that implementation of the existing plans in accordance with the CAs until plans could be formally amended or revised was not likely to jeopardize the DPS, but that amendments or revisions to those plans were needed to further reduce or avoid the potential for adverse effects to lynx (USFWS 2000, pp. 48-50).

In the 2003 remanded rule, the Service similarly determined that adherence to the CAs, the biological opinion, and the LCAS in assessing the impacts of federal actions on lynx alleviated the effects of federal land management activities on lynx, but that amendment of USFS and BLM land management plans to conserve lynx would be the strongest mechanism to ensure long-term conservation of lynx and lynx habitat on federal lands (68 FR 40096-97). It concluded that although federal, State, and Tribal regulations and plans had reduced threats to the DPS, the inadequacy of existing regulatory mechanisms still posed a moderate, albeit lower-level threat, and would continue to do so until federal land management plans were specifically amended to address lynx conservation (68 FR 40097).

Since the 2003 remand, most Forest Service units with lynx forest types have formally amended or revised their land management plans to incorporate the conservation measures, standards, and guidelines identified in the LCAS. From 2004-2006, forest plans for seven national forests with potential lynx habitat in Maine, New Hampshire, Vermont, Michigan, Minnesota, and Wisconsin were revised to include recommendations from the LCAS and the CAs (Jackson 2015, pers. comm.; USFWS 2104, p. 33). In 2007, the USFS completed the Northern Rockies

Lynx Management Direction (NRLMD), which formally amended management plans to include lynx conservation measures, standards, and guidelines for 18 national forests covering over 150,000 km^2 (57,915 mi^2) in Idaho, Montana, Wyoming and Utah, including over 72,000 km^2 (27,800 mi^2) of potential lynx habitat (USFS 2007, entire; USFWS 2014, pp. 16-19; 79 FR 54813; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). In 2008, USFS similarly completed the Southern Rockies Lynx Amendment (SRLA), which formally amended forest plans covering about 59,000 km^2 (22,780 mi^2), including over 30,000 km^2 (11,583 mi^2) of mapped (potential) lynx habitat on 7 national forests or national forest complexes in western Colorado and southern Wyoming (USFS 2008, entire; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). The management direction adopted in the Northern and Southern Rockies amendments was developed in accordance with the National Forest Management Act of 1976 and the regulations that implement the statute (36 CFR 219.22), which requires public review and comment as part of the decision making process. Among national forests within the geographic units evaluated in this SSA, only those in Washington (the Okanogan-Wenatchee and Colville national forests) have not formally amended or revised their land and resource management plans. However, the plan revision process has been initiated for both forests, and both continue to manage for lynx habitats in accordance with the LCAS and the CA.

BLM lands account for just over 1 percent of the total area within the SSA geographic units, and most occur in Colorado, Montana, and Wyoming (Table 1, above). In the Western Colorado SSA unit, BLM Field Offices that contain potential lynx habitat include the Colorado River Valley, Grand Junction, Gunnison, Kremmling, Little Snake, Royal Gorge, San Luis Valley, Tres Rios, Uncompahgre, and White River Field Offices. These BLM areas were subject to the 2000 interagency CA; however, that CA expired in 2004 (BLM and USFWS 2000, p. 8) and was not renewed. Since then, BLM Resource Management Plans (RMPs) have been revised on the Colorado River Valley, Grand Junction, Kremmling, Little Snake, and Tres Rios Field Offices. RMPs for the Gunnison, Royal Gorge, San Luis Valley, Uncompahgre, and White River Field Offices have not been revised and do not contain specific measures for the conservation of lynx. BLM lands in the Garnet Resource Area in Montana and parts of the Kemmerer and Pinedale districts in Wyoming occur within the Northwestern Montana/Northeastern Idaho and GYA SSA geographic areas, respectively. These areas were also designated as lynx critical habitat. The RMP for the Garnet area was amended in 2004 to formally adopt the conservation measures of the LCAS (BLM 2004a, 2004b, entire), and the RMPs for the Pinedale and Kemmerer districts were revised in 2008 and 2010, respectively, to adopt conservation measures and best management practices for lynx (BLM 2008b, pp. A18-10 - A18-16; BLM 2010b, pp. A-9 - A-12).

The completion and implementation of the LCAS, the interagency CAs, and the subsequent formal management plan revisions and amendments all were undertaken to address the inadequacy of regulatory mechanisms on USFS and BLM lands for which the DPS was listed. Each incorporated the best available scientific information to develop goals, objectives, conservation measures, standards, and best management practices (BMPs) to guide USFS and BLM management activities at both project- and landscape-level scales to reduce or eliminate the potential for adverse effects to lynx or its habitats and thus promote the conservation of the DPS (Ruediger *et al.* 2000, pp. 7-1 - 7-18; BLM and USFWS 2000, entire; USFS and USFWS

2000, entire; USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). Standards and guidelines developed and implemented in accordance with the NRLMD and the SRLA were designed to limit potentially adverse effects and promote beneficial effects of management activities (vegetation management [e.g., timber harvest, precommercial thinning], wildland fire and fuels management, grazing, recreation, road/access management, energy development, etc.) on important lynx habitats including winter snowshoe hare habitat (high-quality lynx foraging habitat), denning habitat, and linkage/connectivity corridors (USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). The USFS concluded that the vegetation standards adopted in the NRLMD that limit the total amount and the rate at which lynx habitat can be converted to temporarily unsuitable habitat (stand initiation seral stage following timber harvest) ensure that the agency's timber management program is beneficial to lynx and will provide sufficient lynx habitat through time at both LAU and landscape-level scales (USFS 2007, p. 35). In its biological opinion on the NRLMD, the Service concluded that its application "...would substantially reduce or eliminate adverse effects to lynx from Forest Service land management activities on at least 94 percent of this area, and more likely nearer to 98 percent" (USFWS 2000, p. 76). Similarly, in its 2008 biological opinion on the SRLA, the Service concluded that vegetation management standards in the SRLA would prohibit treatments that could adversely affect essential components of lynx habitat on 95.5 percent of the mapped (potential) lynx habitat in the SRLA area (USFWS 2008, p. 52).

In summary, all USFS and some BLM lands with known or potential lynx habitat within the range of the DPS, including all SSA geographic units, are currently managed in accordance with the specific conservation measures and considerations identified in the LCAS and implemented via the CAs or formally revised and amended management plans described above. These agreements and revised/amended plans constitute the regulatory framework and specific regulatory mechanisms adopted to conserve lynx habitats and populations on USFS and BLM lands that support or are capable of supporting them. They represent the agencies' efforts, in collaboration with the Service, to address and ameliorate the singular threat for which the lynx DPS was listed under the ESA. Although formal effectiveness monitoring has not been completed, it's clear that implementation of the CAs and revised/amended plans, and the associated programmatic and project-specific consultations between BLM/USFS and the Service in accordance with section 7 of the ESA, have resulted in avoidance/minimization of impacts to important lynx and hare habitats on federal lands and have reduced the likelihood that management activities on these lands may adversely affect lynx in the contiguous U.S.

3.1.2 State Regulations and Tribal Management

Private, State, and Tribal lands make up the remaining 36 percent of the lands encompassed by the six geographic units evaluated in this SSA, accounting for almost 27 percent, almost 9 percent, and 1 percent of the total, respectively (Table 1). The amount of private land varies by unit, ranging from 0.3 percent in the North-central Washington Unit to almost 92 percent in the Northern Maine Unit. Likewise, State ownership varies from less than 1 percent in the GYA and Western Colorado units to 36 percent in the Northeastern Minnesota Unit. Tribal lands account for about 4 percent of the Northwestern Montana/Northeastern Idaho Unit and roughly 1 percent

of the Northern Maine and Northeastern Minnesota units; there are no Tribal lands in the North-central Washington, GYA, or Western Colorado units. Private, State, and Tribal lands, combined, constitute all of the lands in the Northern Maine Geographic Unit and over half of those in the Northeastern Minnesota Unit. Because both of these units support larger resident lynx populations than was known when the DPS was listed and, therefore, may contribute more substantially to the conservation of the DPS than was understood at the time of listing, we must evaluate the regulatory mechanisms that pertain to lynx on these lands (Lynx SSA Team 2016, p. 54). Although private, State, and Tribal lands constitute much smaller proportions of the other four (western) geographic units (from about 3 percent to 16 percent, combined), important lynx habitats occur on some of those lands, and regulatory mechanisms may influence their contributions to the conservation and persistence of DPS populations or parts of them. Therefore, in this section, we summarize the relevant regulatory frameworks and mechanisms that may affect lynx on private, State, and Tribal lands within the six geographic units of the DPS, but with a focus on those units with the greatest proportions of these lands and on activities on these lands with the greatest potential to impact lynx.

State Wildlife Management Regulations - The following information is derived from the Service's 2014 Incremental Effects Memorandum prepared in support of the revised designation of critical habitat for the lynx DPS (USFWS 2014, pp. 35-38) and updated as warranted by new information. State furbearer and other wildlife management regulations benefit lynx populations in the states where they occur. In addition to State and private lands, State wildlife regulations govern hunting and trapping activities on many federal lands where those activities are permitted. Most states within the range of the lynx prohibited trapping and hunting of lynx prior to the 2000 listing of the DPS under the ESA, and those activities were prohibited in all states once the DPS was listed. All states within the lynx DPS range that allow legal bobcat harvest (1) manage in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Export Program for Appendix II Furbearer Species (USFWS 2014, pp. 25-26), (2) have distributed information to bobcat trappers and hunters on how to avoid incidental take of lynx, and (3) report all known incidences of incidental take of lynx to the Service's Division of Management Authority to assure that take does not exceed the amount permitted under the intra-agency section 7 consultation for the CITES Export Program (USFWS 2001, entire). Most states have also adopted special regulations in areas where lynx occur to minimize the potential for incidental take of lynx during legal trapping of other furbearers. These efforts benefit lynx and are expected to do so in the future with continued implementation and enforcement.

Unit 1: Northern Maine - In 1967, a bounty on lynx in Maine was repealed, and lynx were given complete protection from trapping and hunting. The Maine Department of Inland Fisheries and Wildlife (MDIFW) has adopted special trapping regulations where lynx may occur that address specifics about traps types and sets that may be used to legally harvest other furbearers and that are intended to minimize the likelihood of incidentally trapping lynx (http://www.eregulations.com/maine/hunting/lynx-protection-zone-trap-restrictions/). MDIFW also adopted and made available for download on its web page the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*, and

modified it to be more specific to Maine. MDIFW also set-up an incidental lynx capture hotline and requires that all incidentally trapped lynx be reported (http://www.maine.gov/ifw/hunting_trapping/trapping/avoid_lynx.htm, last accessed 8.08.2016), and has staff on stand-by to help immobilize, evaluate, collect tissue and/or hair samples, and release, if appropriate, any lynx reported to the hotline. This program has resulted in the release of 98 lynx from 2000 - 2015 (10 died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine (MDIFW 2014, p. 75). In 2014, the MDIFW obtained an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping in Maine. After two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx (see Other Factors in section 4.1.1 below). The regulations now require exclusion devices on killer-type traps, prohibit the use of drag sets on foothold traps, address specific trap types and sets, prohibit visual use of bait and visual attractants, swivels on chains, and require reporting of incidental captures. The trapping permit is currently being litigated in federal court. The MDIFW also is responsible for implementing the Maine Endangered Species Act (http://www.mainelegislature.org/legis/statutes/12/title12sec12803.html; MDIFW 2009, p. 9). Although the lynx is not State-listed as threatened or endangered because its population is estimated to exceed the State's listing threshold, it is considered a species of special concern (MDIFW 2011, p 2). The MDIFW works collaboratively with the Service to conduct research and monitor lynx populations and habitats, and it recommends voluntary forest management activities to promote a sustainable supply and large, connected, and widely-distributed blocks of dense, young spruce-fir stands and to conserve large blocks of unfragmented forestland in northern and western Maine (MDIFW 2011, p. 3).

Unit 2: Northeastern Minnesota - Although lynx were unprotected and had a bounty placed on them in Minnesota prior to 1965, lynx trapping and hunting have been prohibited in Minnesota since 1984 (Moen *in* Lynx SSA Team 2016, p. 19). Overlapping the Northeastern Minnesota SSA unit, the State Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ) for which it has promulgated and enforces special trapping regulations for other furbearers in lynx habitat. The MNDNR has modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (pages 52-54 at: http://files.dnr.state.mn.us/rlp/regulations/hunting/2013/full_regs.pdf). In 2015, the MNDNR issued emergency trapping rules in the LMZ mandating additional restrictions on the types of traps that may be used (MNDNR 2015, entire) to further reduce the likelihood of incidentally trapping lynx. Minnesota DNR is under a federal court order to develop an incidental take plan for lynx and plans to seek an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping. Like Maine, Minnesota has a State Endangered Species Statute (84.0895) which requires the Minnesota DNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern (State of Minnesota 2015, entire). The Statute also authorizes the DNR to adopt rules that regulate treatment of species designated as endangered and threatened. Also like Maine,

Minnesota has designated the lynx a species of special concern (MNDNR 2013, p. 2), and coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats.

Unit 3: Northwestern Montana/Northeastern Idaho - Lynx are designated as a species of concern (S3) by the State of Montana and a species of greatest conservation need (S1) by by the State of Idaho (ILBT 2013, p. 57). The harvest of lynx was prohibited in Idaho and Montana beginning in 1996 and 1999, respectively. Both States participate in the CITES Export Program for bobcats, and both have promulgated and enforce special regulations for the legal trapping of other furbearers in areas occupied by lynx. In its trapping regulations, Idaho Fish and Game (IDFG) provides information on how to distinguish between bobcats and lynx and provides guidelines to reduce injury and minimize non-target catches, including lynx (IDFG 2016, pp. 36-37). Guidelines recommend (1) a minimum 8-pound pan tension on foothold traps set for wolves, (2) specific trap types and sets for other furbearers, and (3) bait and habitat considerations when making sets. Trappers are also required to contact IDFG or local sheriff's offices to assist with the safe release of incidentally trapped lynx. In response to a lawsuit after several lynx were incidentally trapped recently in northern Idaho, the U.S. District Court for the District of Idaho ordered the State to submit "a plan to protect the lynx from future incidental takes in the Panhandle and Clearwater (northern) Regions of Idaho" (U.S. District Court ID 2016, pp. 25-26). The plan has not yet been completed and negotiations between the State and the court are ongoing (Sallabanks 2016, pers. comm.). To minimize and track the incidental capture of lynx, Montana Fish, Wildlife, and Parks (MTFWP) has promulgated an evolving set of trapping regulations and reporting requirements since the DPS was listed (MTFWP 2016, pp. 7-10), including significant changes in 2008 that reduced the reported rate of incidental lynx captures from 1.6 per year in 2000-2007 to 0.4/year in 2008-2015 (MTFWP 2016, p. 5). In 2015, the Federal District Court of Montana approved a settlement agreement reached between the State of Montana and conservation groups aimed at protecting lynx from trapping. The case is now dismissed in accordance with the agreement, which requires Montana to implement a set of reasonable restrictions on trapping in lynx habitat. Currently, these regulations identify designated lynx protection zones (LPZs) and define acceptable trapping methods for public lands within them, which (1) prohibit the use of lethal (non-relaxing) snares for bobcats, (2) specifies the types of sets and baits or attractants that may be used for marten, fisher, and other furbearers where lynx occur, (3) requires a minimum 10-pound pan tension on foothold traps set for wolves, and (4) requires that any incidentally trapped lynx must be released unharmed if possible and reported to MTFWP (MTFWP 2016, pp. 7-10). MTFWP is also responsible for implementing Montana's Nongame and Endangered Species Conservation Act (http://leg.mt.gov/bills/mca/87/5/87-5-103.htm; https://www.animallaw.info/statute/mt-endangered-species-chapter-5-wildlife-protection#87-5-107).

Unit 4: North-central Washington - Lynx harvest was prohibited in Washington in 1991, and the lynx was listed as a State threatened species in 1993 and proposed for uplisting to endangered in 2016 (Lewis 2016, pp. *iii*, 1). Under the State's Endangered Species Program, the Washington Department of Fish and Wildlife (DFW) developed a Lynx Recovery Plan (http://wdfw.wa.gov/publications/00394/) and a Status Report

(http://wdfw.wa.gov/publications/01521/), and it prepares annual reports to update population and habitat information for the species. The DFW also coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats. Additionally, the use of body-gripping traps (foot-hold, conibear, snares, etc.) for trapping other furbearers is prohibited in Washington (except for damage control or nuisance wildlife, which requires special permits). This avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

Unit 5: GYA (Southwestern Montana and Northwestern Wyoming) - See Unit 3, above, for summary of Montana's special trapping regulations to minimize incidental take of lynx. Lynx in Wyoming were offered full protection from trapping and hunting beginning in 1973, and they are designated by the State as a species of greatest conservation need (ILBT 2013, p. 57). The Wyoming Game and Fish Department (WGFD) also participates in the CITES Export Program for bobcats.

Unit 6: Western Colorado - Lynx harvest was prohibited in Colorado in 1970 and the lynx was listed as endangered in the State in 1973. Colorado participates in the CITES Export Program for bobcats, provides information to trappers and hunters on how to distinguish between lynx and bobcats, and requires immediate release of uninjured incidentally trapped lynx as well as reporting of any (uninjured, injured, or killed) incidentally trapped lynx (CPW 2015b, pp. 6-7). Colorado law prohibits the use of foothold or conibear traps and snares for trapping, which avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

State Forest Management Regulations - Timber harvest and other forest management activities on State and private lands are governed by State regulations. Because these activities have the potential for beneficial, benign, or adverse impacts to lynx habitat depending on methods, implementation, and conservation measures, State forestry regulations may influence lynx populations, particularly where substantial amounts of lynx habitat occur on State and private lands. Below, we provide an overview of the forest management regulations in the SSA geographic units and briefly discuss their potential influences on lynx habitat. Additional details on the current and likely future influences of these regulations on lynx populations are provided below in chapters 4 and 5, particularly for the Maine and Minnesota units, where State and private lands constitute the majority of lynx habitats.

Unit 1: Northern Maine - State and private lands constitute 7 percent and 92 percent, respectively, of this SSA unit, with the vast majority of private lands managed for commercial timber production. As described above in section 2.3.2.2 and in more detail below in sections 4.1.1 and 5.1.1, the current abundance of lynx in northern Maine is attributable to the landscape-scale clear-cutting that occurred on private timber lands in the 1970s and 1980s in response to an extensive spruce budworm outbreak, which resulted in the recent unnaturally large amount of young (15 to 35 years post-harvest) regenerating forest in prime hare habitat condition. The amount and distribution of this post-clear-cut excellent hare habitat likely peaked in the late 1990s, when 20-25 percent of the forest in Maine was in an early regeneration stage - 3 to 8 times higher than historic conditions, when only 3-7 percent of stands were likely in such condition at any given time (68 FR 40094). Current timber harvest and management on State

and private lands in Maine are governed by the Maine Forest Practices Act of 1989 and administered by the Maine Forest Service within the Department of Agriculture, Conservation & Forestry to regulate the size, arrangement, regeneration, and management of clearcuts (MEDACF 2014, pp. 42-45). Under the Act, small (up to 250 acre) clear-cuts are still permitted, but require special permits. Because of this regulatory burden, the extensive clear-cutting of the past has largely been replaced by partial harvest techniques that are unlikely to maintain the current unnaturally high amount and distribution of high-quality hare habitat. The consequences of this shift in forest management on Maine's current lynx population, which is also much larger than was likely possible under the natural historic disturbance regime, are discussed below in sections 4.1.1 and 5.1.1, along with other programs that may influence private lands forest management in this unit.

In Maine, there are no long term management agreements in place on private lands to assure management of lynx. In 2006 and 2007, the Natural Resource Conservation Service (NRCS) provided funds to Maine for a pilot Healthy Forest Reserve Program (HFRP) specifically to manage for Canada lynx and American marten. Five landowners enrolled in the program, but one withdrew. The remaining four landowners were provided funding to develop lynx plans on a total of about 630,000 acres (about 10 percent of the critical habitat area). Landowners selected one or two township-sized (23,000 acre) areas within their ownerships to develop and implement a lynx management plan. Thus, about 161,000 acres within the larger area was targeted for managing lynx. All four landowners completed lynx plans using guidelines in the Service's *Canada lynx management guidelines for Maine* (McCollough 2007). NRCS contracts with the landowners last 10 years and will expire in 2016 and 2017. The HFRP described an opportunity for enrollees to apply for Safe Harbor Agreements when their contracts expired, although none have indicated an interest yet in doing so. Management plans were written for a 70-year period so some landowners may continue voluntary lynx management activities. Many private landowners in Maine are enrolled in forest certification programs; the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Both programs require landowners to protect endangered species and their habitats, but there are not specific recommendations pertaining to lynx. About 2.5 million acres in northern Maine is under conservation easement (http://web.colby.edu/stateofmaine2012/state-of-large-landscape-conservation-in-maine/ last accessed 8.18.2016), but easements require management prescriptions or commitments for Canada lynx. To our knowledge, there are no private landowners in Maine who have committed to long-term or permanent protection and creation of lynx habitat according to the Service's lynx management guidelines or LCAS.

State lands include Baxter State Park (~200,000 acres) and the various lots owned and managed by the Maine Bureau of Parks and Lands (MBPL). Most of Baxter State Park is managed as wilderness area, and lynx sightings in the Park are rare because most of the park is mature forest. MBPL integrated resource policy requires that they promote the conservation of federally listed species, but so far no lynx management plans have been developed. Mitigation for Maine Department of Inland Fisheries and Wildlife's incidental take permit for trapping requires management of 6,400 acres of lynx habitat within a 22,000-acre habitat management area on the MBPL's Seboomook Unit for a 15-year period.

Unit 2: Northeastern Minnesota - State and private lands constitute about 36 percent and 16 percent, respectively, of this SSA unit. The Minnesota Department of Natural Resources (MN DNR) Division of Forestry regulates timber harvest and management on State and private lands. Under the Sustainable Forest Resources Act of 1995 (revised most recently in 2014 [MFRC 2014a, p. 1]), the Minnesota Forest Resources Council (MFRC) has developed voluntary guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) that are intended for private and state landowners and include some general recommendations for wildlife including lynx. However, because they are voluntary, the extent to which these guidelines benefit lynx is uncertain (see sections 4.1.2 and 5.1.2 below).

Unit 3: Northwestern Montana/Northeastern Idaho - State and private lands constitute about 4 percent and 8 percent, respectively, of this SSA unit, and almost all are in Montana portion of the unit. The Montana Department of Natural Resources and Conservation (MTDNRC) administers several laws pertaining to forest practices on State and private lands. These laws are intended to protect streamside management zones, reduce fire hazards, and provide BMPs to minimize non-point source water pollution (http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices, accessed July 18, 2016). Although these laws may provide indirect benefits to lynx and other wildlife, they do not include specific measures to conserve or avoid impacts to lynx habitats. However, the MTDNRC and the Service collaborated on a multi-species habitat conservation plan (HCP) for forested State Trust lands that includes a Lynx Conservation Strategy to minimize impacts of forest management activities on lynx and describes conservation commitments that are based on recent information from lynx research in Montana (USFWS 2104, pp. 22-23; 79 FR 54835-54837). This HCP covers about 64 percent of the State lands in this SSA unit, regulates activities primarily associated with commercial forest management to conserve lynx foraging, denning, and connectivity habitats, and includes a 50-year commitment (79 FR 54835-54836). Additional details on this HCP and other programs for conserving lynx habitats on State and private lands in this unit are provided in section 4.1.3 below.

Unit 4: North-central Washington - State and private lands constitute about 8 percent and 0.3 percent, respectively, of this SSA unit.t, and most are State Trust lands in the Loomis State Forest, which accounts for all 426 km^2 (164 mi^2) of State lands in this unit. The Washington Department of Natural Resources (WADNR) administers rules guiding forest practices, such as timber harvests and road building, on State, private, and tribal forests in Washington. The Forest Practices Board, an independent state agency, adopts forest practices rules to protect water quality, fish habitat, other public resources and guide DNR's permitting process for timber harvests and other forest practices statewide. The WADNR developed a Lynx Habitat Management Plan (LHMP) for WDNR-managed lands distributed throughout north-central and northeastern Washington in areas delineated as Lynx Management Zones in the Washington State Lynx Recovery Plan (Stinson 2001; Washington DNR 2006). The WADNR LHMP guides timber harvest and other vegetation management on these lands, including the part of the Loomis State Forest that occurs in this unit, with the goal of creating and preserving quality lynx

habitat through its forest management activities. Additional information on the LHMP are provided in sections 4.1.4 and 5.1.4 below.

Unit 5: GYA - State and private lands constitute about 0.3 percent and just over 2 percent, respectively, of this SSA unit and, combined, likely have little influence on lynx population persistence. Forestry regulations for the Montana portion of this unit (26 percent) are described above. In the Wyoming portion (74 percent of the unit), the Wyoming State Forestry Division is responsible for the management of forested trust land across the state, including timber management and harvest, for long term forest health and productivity. Although the Division's programs may provide some indirect benefits to lynx, they do not include species- or habitat-specific regulations or conservations measures.

Unit 6: Western Colorado - State and private lands constitute about 0.6 percent and over 9 percent, respectively, of this SSA unit. The Colorado Department of Natural Resources and the State Division of Forestry oversee forest management activities on State and private lands in Colorado.

Tribal Management: Tribal lands encompassed by SSA geographic units include those of the Passamaquoddy Tribe and the Penobscot Indian Nation in Maine (248 km^2 [96 mi^2] in Unit 1), Grand Portage Band of Lake Superior Chippewa in Minnesota (202 km^2 [78 mi^2] in Unit 2), and the Confederated Salish and Kootenai Tribes of the Flathead Nation - Flathead Reservation in Montana (958 km^2 [370 mi^2] in Unit 3). Tribal management of these lands is expected to benefit lynx and lynx habitats. No tribal lands occur within SSA units 4, 5, or 6.

Unit 1: Northern Maine - Tribal lands represent less than 1 percent of this unit. The Passamaquoddy Tribe's stated environmental mission is "...to protect the environment and conserve natural resources within all Passamaquoddy lands, waters, and the air we share" (Passamaquoddy Tribe 2014, entire). That of the Penobscot Indian Nation Department of Natural Resources is "...to manage, develop and protect the Penobscot Nation's natural resources in a sustainable manner that protects and enhances the cultural integrity of the Tribe" (Penobscot Indian Nation 2014, entire). Hunting, trapping or possessing lynx are prohibited in accordance with the Penobscot Indian Nation Chapter VII Inland Fish and Game Regulations – Section 204 (Penobscot Indian Nation 2012, p. 15).

Unit 2: Northeastern Minnesota - Tribal lands of the Grand Portage Indian Reservation and the Bois Forte Indian Reservation—Vermillion Lake District represent 1 percent of this SSA unit. The Grand Portage Band of Chippewa has been actively working on lynx conservation since 2004. In October 2007, the Band hosted an international conference on lynx research and conservation where more than 50 researchers from the United States and Canada presented results of research on lynx diet, habitat, and management. Additionally, on-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire).

Unit 3: Northwestern Montana/Northeastern Idaho - Tribal lands of the Confederated Salish and Kootenai Tribes of the Flathead Nation, Flathead Reservation represent nearly 4 percent of this SSA unit. The mission statement of the Tribes' Fish, Wildlife, Recreation and Conservation Division is "...to protect and enhance the fish, wildlife, and wildland resources of the Tribes for continued use by the generations of today and tomorrow" (Confederated Salish and Kootenai Tribes 2014a, entire). An objective of the Tribes' Tribal Wildlife Management Program Plan is to ''. . . develop and implement habitat management guidelines for Canadian lynx in coordination with the Forestry Department as specified in the Forest Management Plan'' (Confederated Salish and Kootenai Tribes. 2014b, p. 5). The Forest Management Plan states that ''Standards for lynx management and habitat protection are set forth in the Canada Lynx Conservation Assessment and Strategy. This strategy guides land management activity in lynx foraging and denning habitat. Lynx occurrence and populations will continue to be monitored on the Reservation'' (Confederated Salish and Kootenai Tribes 2000, p. 285).

In summary, a variety of State wildlife and forestry regulations and conservation efforts, along with Tribal resource management objectives, influence activities in lynx habitats across the range of the DPS. While many of these clearly benefit lynx habitats and likely contribute to the persistence of resident populations, uncertainty remains regarding the effectiveness of some regulations and voluntary programs or measures in maintaining or restoring lynx habitats. This may be especially important with regard to timber management regulations and programs on private lands, which constitute the majority of lands in the Northern Maine geographic unit and a substantial amount of the Northeastern Minnesota unit.

3.2 Climate Change

In 2014, the International Panel on Climate Change (IPCC) released its Fifth Assessment Report, which represents the current scientific consensus on global and regional climate change and the best scientific data available in this rapidly changing field. The Fifth Assessment Report largely reaffirms the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere (IPCC 2014a, entire).

''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat

fragmentation) (IPCC 2007a, pp. 8–14, 18–19). In our analyses, we weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

The IPCC's Fifth Assessment Report concludes that the strongest and most comprehensive evidence of the impacts of climate change is in natural systems, where many species have responded by shifting their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC 2014a, p. 4). The report also concludes that projected climate change during and beyond the 21st Century will increase extinction risk for many terrestrial and freshwater species (IPCC 2014a, pp. 14–15). In North America, observed impacts attributable to climate change that may affect lynx habitats and distribution include upslope and northward shifts in species distributions across multiple taxa, and increased wildfire activity, fire frequency and duration in boreal and subarctic conifer forests of Canada and the western U.S. (IPCC 2014a, p. 31).

At the time of listing, the Service determined there was no evidence to support global warming as a threat to lynx (65 FR 16068-16069). In the 2003 remanded determination, we concluded that the best information available at that time regarding the potential impact of climate change on lynx (warming leading to long-term reductions in snow depths needed to support lynx in the eastern U.S. and eastern Canada south of the St. Lawrence Seaway; Hoving 2001, pp. 72-75) was speculative and did not demonstrate a threat to lynx (68 FR 40083, 40098). In the 2005 recovery outline for the DPS, the Service acknowledged that continued climate warming was likely to negatively affect the boreal forest ecosystem for which lynx are highly adapted, eventually causing it to recede north and/or to higher, colder elevations, potentially resulting in a substantial reduction or even elimination of lynx habitats from the contiguous U.S. (USFWS 2005, pp. 11, 14). In the 2009 critical habitat rule, the Service acknowledged that new science concerning climate change was available, and that climate change may pose a risk to the future conservation of lynx (74 FR 8617, 8621). In the 2014 revised critical habitat rule, we concluded that recent information on regional climate changes and potential effects to lynx habitat (e.g., Knowles *et al.* 2006, pp. 4545–4559; Carroll 2007, pp. 1098–1102; Danby and Hik 2007, pp. 358–359; Gonzalez *et al.* 2007, entire; Iverson *et al.* 2008, pp. 390–400; Beckage *et al.* 2008, entire; Burns *et al.* 2009, p. 31; Johnston *et al.* 2012, pp. 6–13) suggested that climate change is likely to be a significant issue of concern for the future conservation of the lynx DPS (79 FR 54811). Specifically, climate models project reductions in the extent of boreal forest habitats and snow conditions needed to support lynx throughout the DPS, with both features modeled to migrate to higher elevations (in locations where this is possible) and northward in latitude. This would result in fewer, smaller, and more fragmented and isolated areas capable of supporting resident lynx and, therefore, smaller and more isolated lynx populations that would likely be more vulnerable to stochastic environmental and demographic events (79 FR 54811). Climate change also may have synergistic effects with other stressors (e.g., forest insect outbreaks and wildfire frequency, size, and intensity) that could further reduce and isolate lynx populations within the DPS and reduce connectivity to lynx in Canada.

Lynx biologists identify climate change as the most important and overarching factor influencing resiliency of the DPS (Lynx SSA Team 2016, pp. 14, 17, 19, 21-22, 35-47, 50, 53-57; ILBT

2013, pp. 43, 48, 53, 55, 63, 66, 69-71, 98). Climate change is likely to be exacerbated at the southern edge of the range where habitat and snow conditions are patchy and becoming increasingly marginal for the continued existence of lynx (Gonzales *et al.* 2007, p. 8). Across North America, a significant increase in proportion of winter precipitation falling as rain rather than snow has resulted in reduced persistence of the winter snowpack (Dyer and Mote 2006, entire), increased snow density (Hodgkins and Dudley 2006, entire), and decrease in the extent of deeper snowpacks (Dyer and Mote 2006 p. 1, Brown 2000, pp. 2347-2354). Climate change models suggest that future snow cover in the contiguous U.S. will be further reduced in extent and distribution (McKelvey *et al.* 2011, pp. 2892-2896).

Warming and more frequent winter thaws are contributing to changes in snowpack structure, namely replacing deep, fluffy snow with harder, crustier snow, with these conditions occurring at higher latitudes (Callaghan *et al.* 2011, entire) and higher elevations in the Rockies (Abatzoglou 2011, pp. 1138-1141). The frequency of warm spells is correlated to the hardness of the snow surface, sinking depth, and the hunting efficiency of lynx (Stenseth *et al.* 2004, p. 10633). As the climate warms, winter temperatures are rising above freezing more often. This results in more rain on snow events and winter thaws that change the structure of the snowpack; larger grain size, basal ice layers, depth hoar (weak layers in the snowpack), and slip planes (crusts and ice layers within the snowpack) (Callaghan *et al.* 2011, p. 23). Hard snow surfaces (crust) and other structure in the snowpack are believed to reduce the competitive advantage of lynx over bobcats and other mesocarnivore competitors and predators.

Although it is believed that high elevation areas in the West may provide refugia for lynx (Lynx SSA Team 2016, p. 45), these areas will also be affected. Mountainous regions in the western U.S. have historically been strongly snow dominated from November through March. By 2050, the length of snowfall-conducive temperatures over many western mountain ranges will be reduced from approximately five (November–March) to approximately three (December-February) months of the year (Klos *et al.* 2014, p. 4566). Many relatively large areas that contain lower relief, mid-elevation mountain ranges will likely shift relatively quickly into new precipitation phase regimes (e.g., the Northern Rockies, North Cascades)(Klos *et al.* 2014, p. 4566). The interior northwestern U.S. shows a greater sensitivity of its strongly snow-dominated areas to warming because much of the region is characterized by relatively warm winter temperatures and by mainly mid-elevation mountain ranges. The climatic rain-snow transition zone will move up in altitude and latitude.

It is possible that in high elevation areas of DPS in the West, snow conditions suitable for lynx may move up slope at a faster rate than boreal forest habitat will migrate, providing a mismatch of these important habitat elements for lynx. During prehistoric periods of warmer climate, the alpine treeline ecotone (upper elevation of lynx boreal habitat) and deciduous-boreal forest ecotone (lower elevation of lynx boreal habitat) have readily moved upslope in both the northern (Kearney and Luckman 1983) and southern Rockies (Legg and Baker 1980). Boreal treelines in Scandinavia moved upslope an average of 40 m (but up to 100 m) during a recent 50-year period of warming (Kullman 1990). However, despite recent warming, the alpine treeline in North America has thus far remained relatively static (Butler *et al.* 1994). Upslope migration of

the treeline of boreal forest may be limited by high winds, desiccation, and soil depth not conducive to colonization by conifers and will occur either gradually or as a series of scattered, rapid advances as thresholds are crossed (Kupfer and Cairns 1996, p. 259-261). At lower elevations, the upslope movement of the deciduous-boreal ecotone is limited by an isocline of excessively cold winter temperatures (generally -40C), moisture (cloud, fog line), and acidic soils (Kupfer and Cairns 1996, p. 263-264). The rate that boreal forest will retreat upslope is highly speculative depending on how climate change will affect complex moisture and temperature regimes, and there could be a lag time before these community types move up slope (Kupfer and Cairns 1996, p. 268). In the Yukon, upslope migration of spruce-fir seemed to be triggered by climate thresholds and was characterized by slow, gradual change followed by rapid advances (Danby and Hik 2007, p. 361). However, in Vermont, the northern hardwood-boreal ecotone moved upslope 91 to 119 m between 1962 and 2005 consistent with rapidly increasing cloud ceilings in the Northeast, which is believed to be closely associated with this ecotone transition (Beckage *et al.* 2008, pp. 4200-4201).

In contrast, there have been no lag time or thresholds slowing changes in the precipitation and snow regime. Much of the Rockies have already experienced declines in spring snowpack in response to climate change, especially since midcentury, despite increases in winter precipitation in many places (Mote *et al.* 2005, entire; Scalzitti *et al.* 2016, pp. 5367-5368). Some mountainous regions are warming at a faster rate than global land averages (Rangwalla and Miller 2012, entire). It is likely that the losses in snowpack observed to date will continue and even accelerate (Hamlet and Lettenmaier 1999; Payne *et al.* 2004), with faster losses in milder climates like the Cascades and the slowest losses in the high peaks of the northern Rockies and southern Sierras. For every 1 °C increase in temperature, snowline increases about 150 m in elevation (Beniston 2016, p. 106). By 2100, the altitude above which it snows and below which it rains will climb as much as 800 feet in the Colorado Rockies, by 1,400 feet in the Rockies of Idaho and Wyoming, and the snow line will rise by an average of 950 feet across six Western mountain regions if greenhouse gas emissions continue at the current rate (Scalzitti *et al.* 2016, p. 1564). Thus, it is possible that boreal forest will persist for a while, but deep, fluffy snow conditions will retreat upslope and preclude the use of boreal habitat by lynx and instead favor competitors such as bobcats.

The effects of climate warming are already occurring and have accelerated over the past three to four decades (Hansen *et al.* 2006, entire). Globally, greenhouse gas emissions are increasing and tracking levels predicted by models for high emissions scenarios (e.g., RCP8.5) (Peters *et al.* 2013; Friedlingstein *et al.* 2014, p. 709, 712; Fuss *et al.* 2014, p. 851; IPCC 2013, p. 180, 187-189). Analysis of paleoclimate indicates 20th century warming is likely to have been the largest of any century within the last 1000 years (Folland *et al.* 2001, pp. 99-101). These changes are predicted to continue and accelerate under future climate scenarios (Hall and Fagre 2003, Fig. 7). The range of warming projected over this century runs from 3.6 °F (2 °C) to 10.8 °F (6 °C) for North America, with warming higher than this average in areas that are inland, northerly, or mountainous.

Climate change is manifested in different ways throughout the northern contiguous United States and the lynx DPS. To date, the observed and predicted increases in surface temperatures have been greatest in the northern Rockies and Northeast (much of the lynx DPS) than elsewhere in the contiguous United States (IPCC 2014, pp. 12, 61, Workshop Report 2016, pp. 14-15). Climate history and projections from regional climate models for regions associated with the lynx DPS units corroborate global models, and indicate that both eastern and western North America, including all portions of the lynx DPS, have warmed in the last century and are likely to warm 1.8 °F (1 °C) to 5.4 °F (3 °C) by the year 2050 (IPCC 2007b, p. 889). For example, in the Northern Rocky Mountains at Glacier National Park, mean summer temperatures have increased 3.0 °F (1.66 °C) between 1910 and 1980 (Hall and Fagre 2003, pp. 134–137) resulting in lower snowpack, earlier spring melt, and distributional shifts in vegetation (Hall and Fagre 2003, pp. 138–139; Fagre 2005, pp. 4–9).

Climate change is diminishing snow conditions (reduced depth, quality, persistence) considerably throughout the DPS. The strong warming in recent decades corresponded to a large decline in snow cover in North America, particularly in the mountains of the western U.S. (Mote *et al.* 2005, p. 47-48). In most mountain ranges, relative declines vary from minimal at ridgetop to substantial at snow line. Temperature has increased more in the winter than summer (Knowles *et al.* 2006), which has increased the amount of winter precipitation falling as rain instead of snow throughout the DPS (Feng and Hu 2007, entire; Knowles *et al.* 2006, entire, Huntington *et al.* 2004, entire). The rate of decline in the snowpack of the northern Rockies is unprecedented in the last 1000 years (Pederson *et al.* 2011, entire). An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13).

Climate change is expected to substantially reduce the amount and quality of lynx habitat in the contiguous U.S., with patches of high-quality boreal and subalpine forest habitat becoming smaller, more fragmented, and more isolated (Carroll 2007, pp. 1099–1100; Johnston *et al.* 2012, p. 11). Various forms of snow compaction and structure within the snowpack (see above) give a competitive advantage to bobcats and other predators/competitors with higher foot loading that would normally have difficulty traveling and hunting efficiently in deep, fluffy snow conditions (Murray and Boutin 1991, Murray *et al.* 1994, Kolbe *et al.* 2010). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103). These trends indicate the range of the lynx in the DPS is likely to contract as a direct result of climate change. Because of climate change and other stressors, lynx biologists believed that only one to three of the six units may persist to the end of the century (Lynx SSA Team 2016, p. 48).

Near-term effects of climate warming on lynx are more certain than long-term effects. Lynx experts anticipate a downward trend for the probability of persistence of lynx in all six geographic units primarily because of the effects of climate warming (Lynx SSA Team 2016, pp. 35-47). The rates of change and magnitude of effects of climate warming is difficult to predict. Climate change is anticipated to affect each unit differently as summarized below.

Climate change is affecting many of the requirements necessary for the continued existence of lynx in the DPS. Climate warming will continue to stress populations into the foreseeable future. Direct effects to lynx, hares, and their habitat that are occurring or can be reasonably anticipated include 1) range contraction, 2) reduction in the periodicity and amplitude of the hare cycle, 3) reduction in snow conditions necessary to give lynx a competitive advantage, 4) reduction in hare habitat quality and populations, 5) reduction in the amount of lynx and hare habitat in the U.S., 6) changes in the frequency and pattern of disturbance events, 7) introduction of disease and parasites, and 8) reduced gene flow. Synergistic effects between these factors and other stressors (e.g., forest management, trapping, development) may intensify their effects (Carroll 2007). Diminished snow, increasing drought and fire, and increased forest pests and disease are believed to currently be the most important stressors for lynx in the DPS, but it is possible that other pathways are, or may become, equally important. Over the next decades, southern lynx populations will continue to be affected by climate change and associated shifts in habitat, prey base, and competition. The extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in the contiguous U.S. (Murray *et al.* 2008).

Range Contraction in the DPS - In response to climate change, lynx range in the DPS is expected to contract from boreal habitat shifting to higher elevation (Danby and Hik 2007, pp. 360-362) and northward shifts in latitudinal distribution of boreal habitat and snow conditions (Sturm *et al.* 2001, pp. 342-342; Gonzales *et al.* 2010, pp. 761-766; Koen *et al.* 2015. p. 528; ILBT 2013, p. 69). For example, lynx distribution in southeastern Ontario has shifted northward >175 km over the past 40 years (Koen *et al.* 2014, pp. 757-758). Habitat patches will become smaller, more fragmented and isolated (Carroll 2007, pp. 1099-1100; Johnston *et al.* 2012, p. 11), bobcat distribution will expand northward (see below), and lynx will become more vulnerable to stochastic and environmental and demographic effects because of smaller population sizes and increased isolation.

Reduction in Periodicity and Amplitude of the Hare Cycle - Climate change influences ecological processes by altering large-scale climate systems such as the North Atlantic Oscillation, Southern Oscillation, Pacific North American Index, and North Pacific Index which, in turn, affect patterns of temperature and snow in North America (Stenseth *et al.* 2003, entire). Climate change-induced disruptions are believed to have caused the collapse of cycles in voles, lemmings, and snowshoe hares (Ims *et al.* 2008, p. 81; Cornulier *et al.* 2013, entire; Krebs *et al.* 2010, pp. 484-488). The geographical borders between cyclic and noncyclic populations are shifting, and the spatial extents of regions that have cycles are shrinking. The collapse of cycles in herbivores with high-amplitude population cycles also would imply collapses of important ecosystem functions such as pulsed flows of resources and disturbances throughout the

ecosystem, including declines in predator communities (Schmitz *et al.* 2003, p. 1202; Ims *et al.* 2008, p. 85). A common denominator of cycles that exhibit spatial gradients, such as the more pronounced snowshoe hare cycles in the northern part of its North American range, is that the cycles seem to fade as winters become shorter (Ims *et al.* 2008, p. 81).

Changes in large-scale climate systems have already influenced the climate and snow conditions throughout the geographic range of the lynx in North America (Stenseth *et al.* 1999, entire; Krebs *et al.* 2001a, p. 34; Brown 2000, pp. 2347-2354). Yan *et al.* 2013 (p. 3269) provide the first evidence of the negative effects of climate warming on hare-lynx cycles in Canada. The authors concluded that climate forcing is not only essential in producing sustained cycles, but is also essential in modifying the cycle intervals (Yan *et al.* 2013, p. 3269). Collapses in lynx fur harvests in Canada beginning in the mid-1980s may be linked to warming (Yan *et al.* 2013, p. 3269). With more pronounced troughs in hare abundance cycles, lynx populations will decline (Hone *et al.* 2011, p. 424). Diminished lynx populations in the core of the range in Canada is a concern because most of the populations of lynx in the DPS are believed to be dependent on periodic immigration from Canada for demographic persistence and genetic stability (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; U.S. Fish and Wildlife Service 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789, 68 FR 40091, 40097-40100). If diminished amplitude of the hare cycle in Canada continues, it will likely translate into a reduced potential for lynx to expand into new or unoccupied habitat in Canada or the adjoining U.S. (ILBT 2013, p. 69).

Reduction in Snow Conditions that are Necessary to Provide Lynx a Competitive Advantage - Climate-induced changes in snow depth and quality are critical because they reduce the extent of deep, fluffy snow habitat available to lynx (Knowles *et al.* 2006, p. 4557; Carroll 2007, p. 1103; McKelvey *et al.* 2011, pp. 2893-2895; Lynx BioTeam 2012 p. 69; Gonzales *et al.* 2007, pp. 7-8). Across their worldwide distribution, lynx rely on deep, powdery and persistent snow because they restrict potential lynx competitors such as bobcat or coyote and predators such as fishers and cougars from effectively encroaching on or hunting hares in winter lynx habitat (Peers *et al.* 2016, entire; 79 FR 54809).

Warmer winter temperatures are reducing snowpack in all portions of the lynx DPS through a combination of a higher proportion of precipitation falling as rain and higher rates of snowmelt during winter (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Hoving 2001, pp. 73–75; Mote 2003, p. 3–1; Christensen *et al.* 2004, p.347; Knowles *et al.* 2006, pp. 4548–4549). These trends are expected to continue with future climate warming (Hamlet and Lettenmaier 1999, p. 1611; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 48; IPCC 2007b, p. 850). The IPCC (2007b, p. 850) concludes that ''snow season length and snow depth are very likely to decrease in most of North America except in the northernmost part of Canada where maximum snow depth is likely to increase.'' Shifts in the timing of the initiation of spring runoff toward earlier dates in western North America are also well documented (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Cayan *et al.* 2001, pp. 409–410; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 41; Knowles *et al.* 2006, p. 4554). In addition, a feedback (albedo) effect is accelerating the rate of loss of snow cover because of the reflective

nature of snow and the relative heat-absorbing properties of non-snow-covered ground. This feedback effect causes the greatest warming to occur at the interface of snow-covered and exposed areas, increasing the rate at which melting occurs in spring (Groisman *et al.* 1994a, pp. 1637–1648; Groisman *et al.* 1994b, pp. 198–200). This effect has led to the average date of peak snowmelt to shift 3 weeks earlier in spring in the Intermountain West (Fagre 2005, p. 4). This albedo effect is further exacerbated by atmospheric soot and desert dust on snow ((Qian *et al.* 2009, entire; Painter *et al.* 2007, entire) and fire-darkened landscapes (Amiro *et al.* 2006, pp. 47-49). Snow accumulation and duration are expected to decline generally in the geographic areas that contain the central and eastern portion of the lynx DPS (IPCC 2007c, p. 891; Burns *et al.* 2009, p. 31). Because lynx require prolonged periods of deep fluffy snow, current habitats that lose this feature would decline in value for lynx (Hoving 2001, p. 73; Carroll 2007, p. 1092; Gonzalez *et al.* 2007, entire).

Reduced snow depth and duration may reduce lynx's competitive advantage over bobcats, which have similar ecology to lynx but are not as well-adapted to hunting hares in deep fluffy snow (Hoving 2001, pp. 23–24; Carroll 2007, p. 1102; ILBT 2013, pp. 69, 71). The bobcat is the closest related species to lynx in North America, and it outcompetes or displaces lynx wherever the two species overlap, at both broad (Peers *et al.* 2016, entire) and local (Parker *et al.* 1983, Robinson 2006, pp. 120-129) geographic scales. In areas where they do overlap, lynx are subjected to niche displacement to habitats of inferior quality, which probably limits lynx survival and productivity at the southern edge of their range (Peers *et al.* 2016, entire; Robinson 2006, pp. 120). Snow depth likely acts as a mediator of competition between the two species. Bobcats have a higher foot loading than lynx, are unable to hunt hares successfully in areas with deep, soft snow (Krohn *et al.* 2005, pp. 122-129, Hoving *et al.* 2005, entire), and experience high mortality in deep snow winters (Litvaitis *et al.* 1986, p. 116). Lynx have a low foot loading and long legs (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, pp. 122-129) that gives them a competitive advantage over bobcats in deep, fluffy snow conditions. This has important implications for lynx persistence and range distribution at the southern edge of their range considering the current and projected changes in snow cover, stable or increasing bobcat populations in the DPS (Roberts and Crimmins 2010, p. 170), and the predicted northward expansion of bobcats into areas currently occupied by lynx (Lavoie *et al.* 2009, pp. 873-874; Roberts and Crimmins 2010, p. 172; Anderson and Lovallo 2003, p. 758).

Buskirk *et al.* (2000a, entire) described exploitation (competition for food) and interference (avoidance) competition from bobcats and other species that may compete with lynx. Exploitation competition could contribute to lynx starvation and reduced recruitment. Of several predators examined (raptors, coyote, gray wolf, cougar, bobcat, and wolverine), coyotes were deemed the most likely to pose local or regionally important exploitation impacts to lynx. Coyotes, bobcats, and cougars are possibly capable of imparting interference competition effects on lynx. Interference would be most probable during summer and during winter in areas lacking deep, unconsolidated snow (ILBT 2013, p. 36). Cougars are also predators of lynx in the West (ILBT 2013, p. 35), but, like bobcats, cougars also have high foot loading, which limits their efficiency in deep, fluffy snow (Buskirk *et al.* 2000a, p. 90). Fishers are predators of lynx in

Maine (Vashon *et al.* 2012), but their distribution and movements in winter are also limited by deep, unconsolidated snow (Krohn *et al.* 2004, entire).

The effects of lynx-bobcat hybridization on lynx populations in the DPS are uncertain. Bobcats have hybridized with lynx in Minnesota, Maine, and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where low topographic relief and variability in winter severity may allow more interaction between the two species during the breeding season (ILBT 2013, p. 34). Hybrids were capable of reproducing successfully (Homyack *et al.* 2008, p. 507). The hybridization rate is currently low between the species (0.24 percent) but could increase as bobcat populations move north with climate change (Murray *et al.* 2007, p. 1465; Koen *et al.* 2015, p. 528).

Reductions in Hare Populations - In addition to affecting the synchronicity and amplitude of hare cycles, climate change will likely affect hare populations in several different ways, especially at the southern extent of the range. Changing snow conditions may influence lynx hunting behavior and effectiveness. For example, hard-packed snow is reported to be associated with a higher kill rate of hares by lynx and coyotes than soft snow (Stenseth *et al.* 2004, p. 10633, Buskirk *et al.* 2000, p. 94). The higher kill rate could generate a numeric response by lynx and other hare predators (Hone *et al.* 2011, p. 420) that could drive hare populations to lower levels (Stenseth *et al.* 2004, p. 10633). Predator communities are more diverse at the southern part of the lynx range than in central Canada (Murray *et al.* 2008, pp. 1464-1465). The diverse predator community could explain why hare populations have declined and seem to remain low in Maine (Scott 2009, p. 43). Climate change will cause increased annual precipitation, periods of drought and extreme precipitation, and hotter summers across the northern tier of U. S. (i.e., throughout the DPS) in eastern North America (Jacobson *et al.* 2009, pp. 14-15, Romero-Lankao 2014, pp. 1452-1456). Increased precipitation may reduce hare numbers because the second litters of snowshoe hares have lower survival in wet summers (Meslow and Keith 1971, entire). However, because hares have two to four litters per summer, there is opportunity for compensatory survival of later litters if one is affected by weather (Krebs *et al.* 2014, p. 1043). Decreased hare survival may also be expected during prolonged hot, dry summer conditions. For example, hare densities in the GYA are believed to be low, in part, because of the dry conditions there (Hodges *et al.* 2009, p. XX). In dry western forests like those in the GYA, increased precipitation may result in more herbaceous forage and cover, which may promote hare survival and reproduction (Ivan *et al.* 2014, p. 590). Thus, climate change may have both positive and negative effects on hares.

Finally, the shorter duration and diminished snow cover in the DPS is causing an increasingly pronounced mismatch in the phenology of hare pelage change that may reduce hare survival (Zimova *et al.* 2013, entire; Mills *et al.* 2013, entire; 2014, entire). Diminished snow duration by as much as 8 weeks by the end of the century could have population-level effects on hares at the southern edge of their range. Hares exhibit plasticity in the rate at which they can molt from white to brown in the spring, but not in the initiation date of color change or the fall transition from brown to white (Mills *et al.* 2013, pp. 7362-7363). Hares do not seem to compensate for mismatched pelage by changing their behavior related to concealment, thus predisposing them

to predation (Mills *et al.* 2014, entire). There is wide variability in the timing of pelage change by individual hares within populations, and “mismatched” hares experience increased mortality rates (Zimova *et al.* 2016, p. 302). Under high emission scenarios, this could lead to an 11 percent decline in hare survival by mid-century and a 23 percent decline by late century. Diminished survival would lead to steep (high emissions) to moderate (medium-low emissions) declines in hare populations (Zimova *et al.* 2016, p. 304). It is also possible that this phenological mismatch may dampen hare cycles (Zimova *et al.* 2016, p. 305). Snow patterns have been proposed to potentially play a role in dampening cycles (Cornulier *et al.* 2013, pp. 64-65, Sultaire *et al.* 2016a, entire).

The range of the snowshoe hare is contracting northward in the southern part of its range in the contiguous U. S. because of changing snow conditions and reduced survival because of delayed pelage changes (Diefenbach *et al.* 2016, p. 245; Sultaire *et al.* 2016a, entire). In Wisconsin, snowshoe hare range has been contracting northward an average of 8.7 km per decade and will continue to recede northward with climate change (Sultaire *et al.* 2016a, entire). Loss of snow now contributes more than loss of habitat in determining the range of snowshoe hares in the Great Lakes region (Sultaire *et al.* 2016a, entire).

Reduction in Lynx and Hare Habitats - Climate change will diminish the amount of lynx habitat throughout the DPS by a) reducing the areas where snow conditions give lynx a competitive advantage over bobcats and other species, and b) reducing the amount of spruce-fir habitat required by snowshoe hares. An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Areas of contiguous spring snow cover will become smaller and more isolated throughout the Columbia, Upper Missouri, and Upper Colorado Basins, with greatest losses at the southern periphery, which likely is an indicator of the trajectory of lynx habitat (McKelvey *et al.* 2011). Deteriorating snow conditions caused by climate change is causing range contraction of snowshoe hares and the southern edge of their range (Sultaire *et al.* 2016b, pp. 900-904). Similarly, because of diminishing snow resources, potential lynx habitat is diminishing in the northern Appalachians and small areas in the Canadian Maritime Provinces (Carroll 2007, p. 1093).

Changes in temperature and rainfall patterns are expected to shift the distribution of ecosystems northward and up mountain slopes (McDonald and Brown 1992, pp. 411–412; Danby and Hik 2007, pp. 358–359; IPCC 2007c, pp. 230, 232). As climate changes over a landscape, the ecosystems that support lynx are likely to shift, tracking the change of temperature, but with a time lag depending on the ability of individual plant and animal species to migrate (McDonald and Brown 1992, pp. 413–414; Hall and Fagre 2003, p. 138; Peterson 2003, p. 652). On the basis of the best existing data for 130 tree species in North America and associated climate information, and assuming no limitations to individual tree growth, McKenney *et al.* (2007) predicted that the average range for a given tree species will decrease in size by 12 percent and will shift northward by 700 kilometers (km) during this century. In the contiguous U.S., researchers expect that lynx in mountainous habitat will, to some extent, track climate changes

by using higher elevations on mountain slopes, assuming that vegetation communities supportive of lynx and hare habitats also move upslope (Gonzalez *et al.* 2007, p. 7). Some areas of the DPS (e.g., Maine, Minnesota) lack elevational refugia and, therefore, lynx populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102).

These studies predict lynx and hare habitats—boreal spruce-fir and subalpine forests—and, therefore, lynx distribution, are likely to shift upward in elevation within its currently occupied range and recede northward as temperatures increase (Gonzalez *et al.* 2007, pp. 7, 13–14, 19; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, pp. 26–27, 30–31; Vashon *et al.* 2012, pp. 60, 64; ILBT 2013, p. 69). Lienard *et al.* (2016, p. 7) assessed forests in New England, Northern Great Plains, and higher elevations in the Rockies, including spruce-fir types, as vulnerable to drought-related stress from climate change during the next century. The boreal spruce-fir forests that provide habitat for lynx and snowshoe hares are thought to be limited by summer temperatures and drought (Iverson and Prasad 2001, pp.192–196) and, under a suite of emissions and climate change scenarios, are projected to diminish dramatically or disappear from much of the eastern U.S. (Iverson and Prasad 2001, p. 196; Iverson *et al.* 2008, pp. 390–400). Within the last 20 to 25 years, widespread mortality and reduced growth in red spruce in the Northeast are believed to be linked to climate stress (McLaughlin *et al.* 1987, p. 501, Johnson *et al.* 1988, p. 5373.). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103).

Climate change is disproportionately affecting the boreal forest in Canada, the source of lynx dispersing into the DPS. Arctic and alpine ecosystems are among the most sensitive to climate warming (Diaz and Eischeid 2007, entire). Boreal forests have been identified as a critical "tipping element" of the Earth's climate system and are believed to be more sensitive to drought than other forests (Lenton *et al.* 2008, pp. 1788, 1791). Studies suggest a threshold for boreal forest dieback of ~ 3 °C global warming (Lucht *et al.* 2006, entire, Joos *et al.* 2001, entire). Global temperatures are increasing and snowfall is declining at the fastest rate in higher latitudes within the boreal forest region of Canada and Eurasia (IPCC 2007). Predicted changes to the boreal forest are already occurring, and much of the climate-induced change is occurring faster than originally predicted, suggesting rapid change as opposed to slow linear change (Soja *et al.* 2007, pp. 5-6). General circulation models are in agreement that winter warming across the circumboreal region will be in excess of 40 percent above the global mean (Soja *et al.* 2007, p. 4). Increases in precipitation are expected in the boreal region of Canada, particularly during the winter, but may be offset with increases in summer drought, heat stress and evapotranspiration (Stocks *et al.* 1998, entire). Thus, boreal forests are experiencing rapid increases in tree mortality (Peng *et al.* 2011, entire). Several authors have suggested that grasslands, aspen parklands, and temperate forest will expand northward resulting in decreases in boreal forest (Rizzo and Wiken 1992, p. 50; Starfield and Chapin 1996, entire; Rupp *et al.* 2000, entire), which could further fragment spruce-fir habitat (Iverson *et al.* 2008, p. 404; Tang

and Beckage 2010, pp. 152-156; Simons-Legaard *et al.* 2016, p. 5; Rustad *et al.* 2012, p. 15). Climate change is expected to further fragment boreal forest in southern Canada (Hogg 1994, entire) and would reduce habitat connectivity between lynx populations in the contiguous U. S. and southern Canada.

Changes in the Frequency and Pattern of Disturbance Events – The distribution, amount, and composition of lynx habitat could be rapidly and dramatically altered by an increasing occurrence and persistence of drought, along with associated outbreaks of insects and pathogens, wind and ice storms, and wildfires (ILBT 2013, p. 70). All of these factors are potentially interrelated with multiple feedback mechanisms, and some have a cascading effect (Dale *et al.* 2001, p. 729). For example, drought can weaken trees, increasing their vulnerability to insects and pathogens. Insects and pathogens can create dead trees or increase fuel loads, potentially increasing the risk and intensity of fire. The boreal forest is a complex and variable system, and these effects are expected to vary in time and space. Climate change may compound these complex interactions into new domains that may be unprecedented and unpredicted (Dale *et al.* 2001, p. 729). These interactions may appear slowly and be difficult to detect because trees live for so long or they be manifested quickly after a catastrophic perturbation to the forest.

Climate change-induced drought and heat stress have already affected temperate and boreal forest (Allen *et al.* 2010, entire), particularly in the West where tree mortality rates have increased rapidly in recent decades (van Mantgem *et al.* 2009, entire). Droughts occur irregularly in forests in eastern North America and the Pacific Northwest, annually at the end of the growing season in forests at the midcontinental prairie–forest border, and annually in summer in western interior dry forests that depend on winter precipitation (Dale *et al.* 2001, p. 727). Increase in growing-season temperature could increase evaporative demand, triggering moisture stress. Under several climate scenarios, future increases in drought stress are expected in the Southern Rockies and parts of the Northwest (Dale *et al.* 2001, p. 727). The Great Lakes region and parts of the Northwest could experience drought stress within two decades, even though these regions may become wetter in later decades (Dale *et al.* 2001, p. 727).

The frequency of wildfire is increasing in boreal forests of North America. Extended fire seasons and increases in the total area burned are anticipated in the western U.S. with continued climate warming (McKenzie *et al.* 2004). Evaluating wildfire patterns in the western U.S. from 1970-2004, Westerling *et al.* (2006, entire) found rapid and dramatic increases in the frequency of large fires, wildfire durations, and the length of the wildfire season beginning in the mid-1980s. Mesic, middle- and high-elevation forest types (such as lodgepole pine and spruce-fir) in the northern Rocky Mountains experienced the greatest increases. Increased spring and summer temperatures and an earlier spring snowmelt strongly influenced large wildfires, suggesting that climate is the primary driver of these changes rather than fire exclusion (suppression), which appears to have had little impact on natural fire regimes of these higher-elevation forest types in this area ILBT 2013, p. 70).. In contrast, climate change is increasing precipitation in boreal forest regions of eastern North America, which has reduced wildfire frequency (Bergeron *et al.*

2001, p. 388). Under multiple climate scenarios, large increases in fire frequency are expected for boreal forest in central and western Canada, and reduced frequency in eastern Canada - a situation that reflects past Paleoclimates that were warmer than the present (Flannigan *et al.* 2001, pp. 860-862). Increased fire frequency at the grassland – aspen parkland – boreal forest transition in western Canada may hasten the conversion of boreal forest to aspen parkland and aspen parkland to grassland (Flannigan *et al.* 2001, p. 860-861), which could affect connectivity and gene flow in lynx populations.

Warmer springs could increase the frequency and duration of wildfires, which in turn could increase vulnerability of surviving trees to bark beetle attack (Westerling *et al.* 2006; ILBT 2013, p. 70). Increasing temperatures and forest homogeneity could create conditions favorable for bark beetle outbreaks that exceed natural disturbance thresholds, perhaps increasing the likelihood of additional outbreaks in the resulting large areas of even-aged forests (Raffa *et al.* 2008; ILBT 2013, p. 70).

Climate change is dramatically affecting the frequency and intensity of some eruptive boreal forest insect pests and pathogens that affect disturbance patterns in spruce-fir forests. Changes in temperature and precipitation affect herbivore and pathogen survival, reproduction, dispersal, and distribution. For example, native bark beetles, such as the spruce beetle and mountain pine beetle, are key agents of change in coniferous forest ecosystems in western North America and have recently defoliated millions of hectares – among the largest and most severe in recorded history (Bentz *et al.* 2009). Drought-stressed conifers have increased vulnerability to insect attack. By the end of the century, changes in temperatures across the boreal forests of western North America may cause markedly high probability of outbreak of these species (Bentz *et al.* 2010. pp. 607, 609). In contrast, the range of the spruce budworm, a major pest of spruce-fir ecosystems in eastern North America, is expected to shift northward reducing vulnerability of spruce-fir forests in Maine and Minnesota (Regniere *et al.* 2010, entire). However, widespread clearcutting following the most recent spruce budworm outbreak in Maine was the primary driver creating widespread lynx habitat (Hoving *et al.* 2005, Vashon *et al.* 2012).

Introduced species can affect forests through herbivory, predation, habitat change, competition, alteration of gene pools via hybridization with natives, and disease (as either pathogens or vectors) and can alter the diversity, nutrient cycles, forest succession, and fire frequency and intensity of some ecosystems (Dale *et al.* 2001, p. 727). Climate change will modify the distributions of many introduced species. Currently, there are few exotic species in North American boreal forests. This is likely because remote areas with little human intervention receive fewer exotic species. However, exotic species could be introduced in the future as boreal systems are increasingly exploited for forest products, mining, energy production, and other natural resources (Schinder and Lee 2010, entire).

Ice storms occur throughout the northern U.S.but are most frequent in the Northeast (Dale *et al.* 2001, p. 728). For example, in January, 1998 a severe ice storm extensively damaged the canopy of many northeastern U.S. and eastern Canadian forests, causing moderate to severe forest damage to over 10 million acres in the Northeast U.S. and southern Quebec (Irland 2000,

entire; Millward and Kraft 2004, entire; Jones and Mulhern 1998, p. 19). Ice storm damage to stands can range from light and patchy to total breakage of all mature stems over extensive areas (Irland 2000, entire). It is uncertain how climate change will affect the frequency, intensity, location, and extent of ice storms; however, atmospheric warming will most likely shift the locations of prevailing ice storms northward.

Introduction of Lynx or Hare Disease and Parasites - Climate change can increase pathogen development and survival rates, disease transmission, and host susceptibility, and some species are predicted to experience more frequent or severe disease impacts with warming while others may be relieved of pathogens (Harvell *et al.* 2002, entire, Harvell *et al.* 2009, entire). Climate change is likely to cause major changes to the geographic range and incidence of insect and tick-borne diseases (Daszak *et al.* 2000).

No apparent climate-influenced parasites or diseases have been identified that would affect Canada lynx or snowshoe hares, but experts believed this was difficult to predict and a possibility (Lynx SSA Team 2016, pp. 27, 37-39). A few pathogens have been documented in lynx in the DPS. For example, plague, a flea-borne disease caused by the bacterium *Yersinia pestis*, which is not native to North America, was reported for the first time in lynx in Colorado (Wild *et al.* 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 lynx released in Colorado between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to *Y. pestis*; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado. Exposure of some lynx to feline parvovirus was detected in six areas in western North America (Montana-Alaska)(Biek *et al.* 2002). *Troglostongylus wilsoni* is a nematode that infects the lungs of lynx and bobcats (Sarmiento 1956, Van Zyll de Jong 1966, Kumar 1974, and Reichard 2004) and was detected in Maine lynx (Vashon *et al.* 2012, p. 24). Lynx with heavy infestations have difficulty breathing and succumb to starvation, as occurred with several Maine lynx (Vashon *et al.* 2012, p. 24).

Reduction in Gene Flow - Koen *et al.* (2014, entire) hypothesized that climate change would create increasingly unsuitable environmental conditions for lynx (e.g., milder winters with reduced snow quality, declining and fragmented boreal forest), which was associated with low genetic diversity and high genetic differentiation at the trailing (southern) edge of the range. Furthermore, high winter temperature, low snow depth, and low proportion of suitable habitat were strongly correlated with neutral genetic diversity, low allelic richness, and high genetic differentiation (Koen *et al.* 2014, p. 757). The authors surmised that genetic structuring in southern lynx populations could be caused by a northward shift in optimal conditions, resulting in isolation and extirpation of lynx populations at the trailing edge of their range or climate-induced changes in the distributions of snowshoe hare or bobcats causing lynx to shift northward. Lynx with the greatest allelic richness were found in areas with the deepest snow in the core of their range in northern Ontario (Koen *et al.* 2014, p. 758). The authors concluded that climate warming has reduced gene flow at the receding (southern) edge of the lynx's range, and that southward gene flow from Canada into threatened U.S. populations is unlikely (Koen *et al.* 2014, p. 760). Stenseth *et al.* (2004, entire) documented population and genetic structuring in the lynx populations east and west of Hudson Bay based on differences in snow conditions on

either side of this divide. This may be explained by the reluctance of lynx to disperse between areas having different snow regimes and snow quality. Snow conditions may be the key factor in the spatial, ecological, and genetic structuring of Canada lynx (Stenseth *et al.* 2014, pp. 10633-10644).

Climate warming may further isolate lynx populations, thus reducing gene flow, by reducing connectivity between populations. For example, gene flow between eastern Canada and Maine lynx populations depends on an ice bridge for dispersal across the St. Lawrence River. Although some lynx currently cross the river, Koen *et al.* (2014, entire) found genetic structuring on either side of the river. Thus, the river already restricts gene flow. Climate-induced deteriorating ice conditions on the St. Lawrence River could further restrict gene flow between lynx populations north and south of the river (Koen *et al.* 2014, p. 528). Between 1969 and 2002 there was a 20 to 40 percent reduction in sea-ice cover during the spring thaw in the Gulf of the St. Lawrence (Johnston *et al.* 2005). Conversely, reduced ice on the St. Lawrence may prevent bobcats from dispersing northward into lynx areas in central Quebec (Koen *et al.* 2014, p. 528).

3.3 Vegetation Management

Forest management occurs across the range of the lynx and can directly affect important habitats and prey. At the time of listing, management activities uninformed by consideration of negative impacts to the species were identified as being of greatest potential concern to lynx conservation (68 FR 40076-40101). Forest management is the most prevalent land use throughout the lynx DPS and can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitat and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Forest management affects stand structure, composition, and arrangement on the landscape, which are important elements of habitat for snowshoe hares and lynx. At the home range scale, lynx throughout the DPS select landscapes having the greatest snowshoe hare densities. In Maine and Minnesota these are young, regenerating spruce-fir forests (Hoving *et al.* 2004, McCann and Moen 2011) and in the West regenerating lodgepole pine (Koehler, Maletzke, Berg *et al.* 2012) and dense mature conifer forest, as well as young stands with dense spruce-fir saplings (Griffin 2004, Squires *et al.* 2010, pp. 1648, 1653–1656; Berg *et al.* 2012). Silvicultural prescriptions and cutting practices in boreal forest types vary widely throughout the lynx DPS depending on the landowner, forest ecology and ecoregion, tree species, site conditions (e.g. moisture, slope, aspect), disturbance regimes (e.g., fire, insect outbreaks), forest policy and regulations, logging equipment, and markets for forest products. Forest management that creates habitat for hares and lynx in one geographic area may not be beneficial to hares and lynx in another.

Nevertheless, snowshoe hares throughout the DPS range respond to one common denominator. Dense understory (horizontal cover) is the most important forest structural characteristics for hares throughout their range (Ferron and Ouellet 1992, Wolfe *et al.* 1982, Litvaitis *et al.* 1985). Dense, horizontal cover provides hares with a source of browse and cover from predation. Softwood (e.g., spruce-fir) has about three times more cover value than hardwoods (Litvaitis *et al.* 1985). Thus, stem density (or stem cover units) and snowshoe hare

density are directly and positively correlated (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Koehler and Brittell 1990, Thomas *et al.* 1997, Hodges 2000a, Mowat *et al.* 2000, Homyack *et al.* 2006, Robinson 2006, Scott 2009, Fuller and Harrison 2013). Forest practices that promote high stem density and dense horizontal cover can increase snowshoe hare densities (Keith and Surrendi 1971; Fox 1978; Conroy *et al.* 1979; Wolff 1980; Parker *et al.* 1983; Livaitis *et al.* 1985; Bailey *et al.* 1986; Monthey 1986; Koehler 1990a, b; Robinson 2006; Fuller *et al.* 2007; Homyack *et al.* 2007; Scott 2009; McCann and Moen 2011). Forest practices that reduce dense understory generally reduce habitat quality for hares and lynx.

Effects of forest practices on snowshoe hare habitats have been studied across the range of the species (Conroy *et al.* 1979, Sullivan and Sullivan 1988, Koehler 1990b, Thomas *et al.* 1997, Homyack *et al.* 2005, Robinson 2006, Griffin and Mills 2007, Scott 2009, Berg 2010, Ivan 2011a, Lewis *et al.* 2011, McCann and Moen 2011). Similarly, the effects of forest management on lynx habitat use, movements, and home range have been investigated by Koehler (1990a), Koehler and Brittell (1990), Fuller *et al.* (2007), Homyack *et al.* (2007), Moen *et al.* (2008), Vashon *et al.* (2008b), Simons (2009), Squires *et al.* (2010), Simons-Legaard *et al.* (2013), Simons-Legaard *et al.* (2016).

Historically, the dominant natural disturbance processes that created young, regenerating conifer forest conducive to hares and lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of northern Maine, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S. After disturbances, forests generally develop through several stages described by Oliver (1980) as “stand initiation,” “stem exclusion,” “understory reinitiation,” and “old growth.” Stand dynamics, particularly within-stand competition for light, nutrients, and space, determine how forests grow and respond to intentional manipulations and natural disturbances (Oliver and Larson 1996). The frequency and severity of disturbances have a large role in determining which species will dominate in a stand after the disturbance event. Snowshoe hare and lynx habitat are created during the stand initiation stage, after the young trees have established and grown tall enough (1-3 meters) to protrude above the snow and provide adequate horizontal cover. During the stem exclusion stage (~10 meters depending on tree species) the tree crowns lift and lower branches self-prune, thus reducing the live horizontal branches providing food and cover for snowshoe hares. In the old growth stage, understory may re-develop (e.g., in forest gaps where mature trees die or fall down) and food and cover may again become available to support snowshoe hares.

Commercial timber management of conifer forests traditionally has been designed to: in very young, regenerating forest to select for desired species (e.g., herbiciding, plantations) and reduce tree density to promote tree growth (e.g., precommercial thinning); in young middle-aged forest to improve growth and vigor of mature trees (e.g., commercial thinning, pruning, thinning from below); and in mature forest to reduce the vulnerability of commercially valuable trees to insects, disease, and fire (e.g., commercial thinning, group selection, fuels reduction). The

culmination of the process (or a forest rotation) is harvesting of forest products. Just as the timing and intensity of a natural disturbance affects the composition of the succeeding forest, the season, climate, machinery, and type of final harvest (e.g., clearcut v. partial harvest) have a large role in determining the species composition and health of the next crop of trees. Timber management practices may mimic natural disturbance processes but often are not an exact ecological substitute. Some practices, such as use of herbicides to suppress hardwood regeneration or plantations do not have an historical analogue. Timber harvest may differ from natural disturbances by:

- Removing most standing biomass from the site, especially larger size classes of trees, and down logs, which alters microsite conditions and nutrient cycling;
- Creating smaller, more dispersed patches and concentrating harvest at lower elevations in mountainous regions and on more nutrient rich soils, resulting in habitat fragmentation;
- Causing soil disturbance and compaction by heavy equipment, which may result in increased water runoff and slower tree growth at the site; or
- Giving a competitive advantage to commercially-valuable tree species and reducing the structural complexity of the forest through the application of harvest, planting, thinning, and herbicide treatments.
- Forest practices often have a smaller footprint on the landscape than widespread fire, insect, or wind damage.

Forest management may (or may not) be compatible with creating or maintaining habitats capable of supporting hares and lynx. Where the objective is to provide snowshoe hare habitat by creating additional early-successional forest conditions, management considerations include selecting areas that are capable of, but not currently providing, dense horizontal cover, designing the appropriate size and shape of treatment units, retaining coarse woody debris, and maintaining high stem densities in regenerated forests (Koehler and Brittell 1990, Homyack *et al.* 2004, Bull *et al.* 2005, Fuller and Harrison 2005, Ivan 2011a).

North America is the world's leading producer and consumer of wood products. Therefore, worldwide trends in forest products markets greatly affect forest management outcomes and thus, the amount and quality of lynx habitat in the DPS. Forest management decisions (e.g., to focus on hardwood or softwood production) can change dramatically in response to unpredictable and changing forest products markets. Globalization of manufacturing and expanded use of electronic media have reduced demand in pulp and paper since the late 1990s, and the collapse of housing construction since 2006 have contributed to declines in U. S. wood product output. Within the northern region of the U. S. (Maine to North Dakota) there has been a considerable decline in terms of employment, mill numbers, wood consumption and forest harvests since 2000 (Woodall *et al.* 2011). As a large amount of this region's forest industry is print paper manufacturing and composite panel production, the rise of electronic media and decline of home construction has precipitated a decade of decline, which only deepened since the recession of 2007-2009. The West, prior to the recession, was a major softwood lumber producing region, and was particularly hard hit by the recession and housing

collapse. Employment dropped by 30 percent or nearly 80,000 workers and annual value of output fell by more than 25 percent (Keegan *et al.* 2011). Under depressed markets, landowners may reduce harvests, which may be to the detriment of lynx in some parts of the DPS (e.g., Maine and Minnesota), and to the benefit of lynx in others (the West).

Markets for softwood products are particularly volatile and depend on demand for paper and housing. Thus, softwood management is affected by economic factors that are difficult to predict. In recent years, the forest products industry throughout the U. S. experienced a downturn in output levels not seen in decades, and employment losses in the hundreds of thousands (Woodall *et al.* 2011, p. 595). Despite depressed markets, one area of increasing interest is bioenergy production. Rising energy costs and growing concerns over global climate change have increased interest in bioenergy production, and the U. S. Energy Independence and Security Act (2007) mandates a five-fold increase in biofuel production (Benjamin *et al.* 2009, p. 125). The wood pellet sector is expected to grow, although woody biomass is typically the lowest value wood commodity sold from the forest. Thus, it is questionable whether wood energy revenues would be enough to sustain forest investments and forest management into the future (Woodall *et al.* 2011, p. 601).

Whereas management of state and federal forest lands have been relatively stable in recent decades, management and ownership of private forest land ownership has been extremely unstable. This has resulted in major shifts in forest management strategies, outcomes, and products. For example, in the last two decades in Maine, where nearly all the lynx critical habitat is on private land, about 23.8 million acres (80 percent) of industrial land ownerships in the "northern forest" (Adirondacks to northern Maine) were sold to a host of financial groups (Hagan *et al.* 2005). These groups have short-term investment goals and different management objectives and have dramatically changed harvest practices. Whereas the previous large industrial landowners focused on the forest land base as a supply for their manufacturing facilities, the new TIMOs and REITs focus on maximizing return on their investment (Jin and Sader 2006, p. 178). Initially, the effects of ownership changes were uncertain (McWilliams *et al.* 2005), but an evaluation of harvesting in the last decade indicates these landowners increased harvest rates, shortened rotation rates, and shifted to managing and harvesting hardwood tree species (Jin and Sader 2006, p. 183-185). On one hand, these trends in Maine private lands management make lynx management commitments more difficult because short-term landowners are not interested in long-term commitments. On the other hand, some easement owners may have an incentive to manage for lynx to meet forest certification requirements.

The extensive sale of private forestlands initiated the growth of conservation easements in this region (deGooyer and Capen 2004, Lilieholm *et al.* 2010). Conservation land as a percentage of Maine's state area increased from less than 5 percent in 1987 to approximately 19 percent by 2012 (Beck *et al.* 2012, p. 15). Conservation easements restrict development but usually do not affect forest management; neither do they typically require management for lynx and other rare species. Some private forestlands were sold to state and federal agencies and conservation interests. For example, in recent years The Nature Conservancy purchased 310,000 acres of

private forestland in Montana and 185,000 acres of private forestland in northern Maine. Lands in conservation ownership have a high probability of being managed to benefit hares and lynx.

Finally, future trends in forest management will be affected by climate change (Irland *et al.* 2003, entire). Many models have been developed to project how U.S. timber production and markets may adapt to climate change (e.g. Burton *et al.* 1998, Joyce *et al.* 1995, Perez-Garcia *et al.* 1997, Sohngen and Mendelsohn 1998). Economic models predict that under climate change, total U.S. timber inventories will increase, timber harvest will increase, and product prices will decrease relative to an assumed stable climate. Some models predict that consumers will gain from climate change while landowners in some regions will lose. The forest industry will adapt to climate change in many ways including using alternate tree species in manufacturing, shifts to geographic regions of the country with economic advantages in timber growth, and increasing forest plantations with new species that are favorably adapted to the new climate and markets. Many strategies have been evaluated to increase the quantity of carbon stored in North American forests (Irland *et al.* 2003) including discontinuing or greatly reducing harvest in some forests to build carbon reserves, increased recycling to reduce use of forest products, converting agricultural lands to forests, and substituting wood products for more energy-intensive products. Increased atmospheric carbon will increase forest growth slightly, except for softwood (Irland *et al.* 2001, p. 757-758). Sawtimber production, which sequesters more carbon, is expected to increase (Irland *et al.* 2001, p. 758). Expanding landscapes with older growth conifer forest to sequester carbon could benefit lynx in the West and be to the detriment of lynx in the East.

Climate change will affect forest-related recreation. Warmer lowland temperatures will attract more people to relatively cooler mountainous and northern forests (Irland *et al.* 2001, p. 759). The ski industry is currently in decline, and climate-induced changes in snowfall will further stress this industry, except for higher elevation western resorts where snowfall is more dependable and where artificial snow is less expensive to make (Irland *et al.* 2001). These climate-induced trends in recreation are anticipated to bring more people into the lynx DPS, which could bring additional social pressures concerning decisions related to forest management (e.g. clearcutting) (Swanson and Loomis 1996). At this time, there are many uncertainties concerning the socioeconomic implications of climate change and adaptation in the northern forests supporting the lynx DPS.

Past and future forest management affects many of the requirements necessary for the continued existence of lynx in the DPS. Forest management is expected to be the predominant land use throughout the DPS into the foreseeable future, and major climate-induced changes in forest industry are anticipated (Irland *et al.* 2001, entire). Beneficial effects of forest management include 1) creating lynx habitat, 2) maintaining an undeveloped landscape conducive to lynx, and 3) long term management planning for lynx (especially on federal lands). Adverse effects to lynx, hares, and their habitat that are occurring or can be reasonably be anticipated include 1) reduced quality of hare habitat in some parts of the DPS, 2) loss and fragmentation of lynx and hare habitat in the U. S., and 3) changes in the frequency and pattern of disturbance events. Synergetic effects between forest management and other stressors (e.g.,

climate change, trapping, development) may intensify their effects (Carroll 2007). Habitat loss and fragmentation are believed to currently be the most important stressors for lynx in the DPS (Fig. X), but it is possible that other pathways for forest management are, or may become, equally important. Hares and lynx will continue to be affected (both positively and negatively) by forest management into the foreseeable future. Forest management stressors primarily affect lynx by lowering landscape hare densities, which in turn reduce lynx reproduction and lower

Reduced Quality of Hare Habitat - Throughout the lynx DPS, some vegetation management practices, especially thinning in young, dense regeneration, reducing overstory canopy in mature multi-story spruce-fir forests (in the West), and partial harvesting (in northern Maine) reduce the quality of boreal forest habitats for snowshoe hares and lynx. This could cause lynx to increase their home ranges, reduce productivity, or in extreme cases to abandon their home range or cause mortality.

Thinning of young, dense sapling stage conifers (precommercial thinning) is a forest management practice used widely throughout the DPS to increase the growth and value of selected trees and to reduce the time to maturity of a stand of trees. Precommercial thinning removes competing trees of the same species or shrubs and trees of other species (Daniel *et al.* 1979; Homyack *et al.* 2005, 2007). Reducing the density of sapling-sized conifers in young regenerating forests to increase the growth of certain selected trees promotes more homogeneous patches and reduces the amount and density of horizontal cover, which is needed to sustain snowshoe hares (Sullivan and Sullivan 1988, Hodges 2000b, Griffin and Mills 2004, Ausband and Baty 2005, Griffin and Mills 2007, Homyack *et al.* 2007, Ellsworth 2009). Hares reach highest densities in stands with stem densities ranging from 4,600–33,210 stems/ha (1,862–13,445 stems/ac)(Wolff 1980, Parker 1984, Litvaitis *et al.* 1985, Monthey 1986, Parker 1986, Koehler 1990a, Griffin 2004, Fuller and Harrison 2005, Robinson 2006, Scott 2009), whereas thinned stands have densities of 2990 (6-foot spacing) to 1,682 (8-foot spacing) stems/ha (Pitt and Lanteigne 2008, p. 593). Precommercial thinning has been shown to reduce hare numbers by as much as 2- and 3-fold (Griffin and Mills 2004, 2007; Homyack *et al.* 2007) because of reduced cover and decreased availability of browse. Griffin and Mills (2007) reported that, if their results were representative, the practice of precommercial thinning could significantly reduce snowshoe hares across the range of lynx.

There are anecdotal examples of precommercially thinned stands that subsequently "filled in" with understory trees. Some have suggested this could be a technique to extend the time that understory trees and low limbs provide the dense horizontal cover that constitutes snowshoe hare habitat. The duration between time of thinning and regrowth to a height providing winter snowshoe hare habitat would likely vary by tree species, each having different regenerative capacities that could be influenced by a variety of local factors (e.g., topographic relief, moisture, and mineral and organic content of the soil; Baumgartner *et al.* 1984, Koch 1996). Bull *et al.* (2005) reported that the slash and coarse woody debris remaining after precommercial thinning provided both forage and cover for snowshoe hares up to a year following treatment. However, Homyack *et al.* (2007) found that snowshoe hare densities were reduced following precommercial thinning for 1–11 years post-thinning. They further suggested that after

precommercial thinning, the stands did not regain the structural complexity in the understory that would be needed to support pre-treatment snowshoe hare densities. At this time, no other data are available to quantify the re-establishment of snowshoe hare habitat and over what time period, or the response by snowshoe hares, as compared with sites that were not precommercially thinned, so this remains an unproven management technique. As an alternative to standard precommercial thinning (i.e., complete thinning resulting in a homogeneous patch), Griffin and Mills (2007) suggested retaining at least 20 percent of the patch in untreated clumps of about ¼ ha (½ ac), which would maintain hare habitat in the short term. However, Lewis *et al.* (2011) found that landscapes with patches of high-quality habitat surrounded by similar vegetation supported more hares than did more fragmented landscapes composed of high-quality patches in a matrix of poorer-quality habitat. Further long-term studies of modified thinning methods are needed.

Because of documented adverse effects of precommercial thinning to snowshoe hares and lynx, in 2007 and 2008 the USFS amended Forest Plans to incorporate management that would conserve lynx, including direction that prohibited precommercial thinning in most lynx foraging habitat (USFS 2007, pp. 8, 11-14, 36; USFS 2008, pp. 6-9, 23-26) . However, precommercial thinning is not regulated on private forest lands throughout the remainder of the DPS.

Uneven-aged management (single tree, partial harvest, and small group selection) practices can be employed in stands where there is a poorly developed understory, but have the potential to produce dense horizontal cover for snowshoe hares. Removal of select large trees can create openings in the canopy that mimic gap dynamics and help to maintain and encourage multistory attributes within the stand. However, if removal of large trees opens the canopy to the extent that the patch functions as an opening, this may discourage use by lynx (Koehler 1990a, von Kienast 2003, Maletzke 2004, Squires *et al.* 2010). Removal of larger trees from mature multi-story forest stands to reduce competition and increase tree growth or resistance to forest insects may reduce the horizontal cover (e.g., boughs on snow), thus degrading the quality of winter habitat for lynx (Robinson 2006, Koehler *et al.* 2008, Squires *et al.* 2010). Similarly, removing understory trees from mature multi-story forest stands reduces the dense horizontal cover selected by snowshoe hares, and thus reduces winter habitat.

Partial harvesting broadly describes many methods of removing a portion of the overstory trees from a forest stand. Partial harvesting includes selective cuts, shelterwood cuts, and uneven-aged management. Partial harvest may be “light” (e.g., <10 percent of trees removed) to “heavy” (e.g., 90 percent of trees removed). Since passage of the Maine Forest Practices Act in 1989, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine (Sader *et al.* 2003, entire). In recent years, about 425,000 acres of Maine forest are harvested annually and 96 percent of this land is partially harvested (Maine Forest Service 2016? Check). After 17 years of extensive partial harvests, much of the northern Maine landscape has been influenced by this form of forestry, and will continue to be into the future. The popularity of this form of harvesting extends beyond Maine. From the mid-1980s to mid-1990s, partial harvesting comprised 62 percent of the harvest in the U. S., and clearcuts comprised the other 38 percent. Partially harvested stands result in a wide range of

residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006). On average, partially harvested stands supported about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006). Shelterwood cuts, a form of even-aged management, are the exception and have maintained densities similar to regenerating clearcut stands (D. Harrison, U. Maine, unpubl. data). Current hare densities in partially harvested stands in Maine average about 0.4 hares/ha (Simons 2009, p. XXX, check), which is below the landscape hare densities (0.5 hares/ha (Ruggiero *et al.* 2000b, Simons-Legaard *et al.* 2013) needed to support lynx.

In the Great Lakes Geographic Unit, prescribed burning is used in lynx habitat primarily as a tool to reduce fuels (including from blow-down) and mimic a more natural fire regime in pine forest types (Plate 4.4). In these instances there is a short-term (10–30 years) impact on snowshoe hare habitat. In the western U.S., prescribed fire for ecosystem restoration is most applicable to the dry ponderosa pine and Douglas-fir forests that are not lynx habitat. Because spruce-fir forests are generally composed of thinner-barked trees that are easily killed even with light fire, this technique is not used frequently in most lynx habitat.

Biomass removal for energy production targets the removal of dead trees, logging slash, and small-diameter trees and shrubs. Biomass removal is similar to fuels treatments in reducing cover and habitat for snowshoe hares.

Fuels treatments commonly are designed to remove understory biomass and reduce stem density in forests that are outside their historical range of variability, and to clear fuels adjacent to human developments for safety or to protect investments (Plate 4.3). These types of projects are becoming more common. In the western U.S., projects designed to restore forests to a condition more representative of the historical range of variability are generally targeted to drier, lower-elevation forests affected by fire suppression (Hessburg *et al.* 2005), which are not lynx habitat. Lynx habitats in higher-elevation spruce-fir forests have been less affected by past fire suppression and are mostly within the historical range of variability (Agee 2000). Fuels treatments may be needed to protect human communities and capital improvements by reducing the intensity and rate of spread of a fire, affording control actions with a higher probability of success and providing safer conditions for firefighters. By removing or reducing the understory and ladder fuels to meet those objectives, dense horizontal cover important to snowshoe hares is reduced and habitat value is diminished for hares and lynx.

Loss, Degradation and Fragmentation of Boreal Forest Habitat - Forest management rarely results in conversion of lands to non-forest. In fact, forested landscapes have increased in some parts of the DPS (especially in the Northeast) because of farm abandonment and recolonization by second-growth forest. However, some forms of forest management such as selective harvesting and fire suppression can intentionally (or not) alter tree species composition away from boreal forest types that support snowshoe hare and lynx. Similarly, lack of forest management can alter tree species composition (Trani *et al.* 2001, pp. 415-417). Other stressors, such as insects and climate change, can work in synergy with forest management to reduce boreal forest. For example, in northern New England clearcutting leads to drying of the

forest floor and consequent heavy mortality in spruce and fir regeneration and increased light levels that increase hardwood competition (White and Cogbill in Eagar and Adams 2012, p. 32).

Plantations can convert native forest communities into monocultures of a native or exotic tree species that may lack hardwood browse for snowshoe hare. Cutting rotation can be reduced by half through mechanical site preparation, planting, and suppression of hardwood competition. Conifer stem densities in plantations range from 800-5,000 stems/ha and may support relatively low populations of snowshoe hares because of the initial wide spacing of trees (Bellefeuille *et al.* 2001, p. 44). Hare densities may increase after trees in a plantation reach the sapling stage and branches intermingle at the ground level creating horizontal cover if the lateral branches are not pruned (Parker 1984, p. 163, Parker 1986 p. 160, Roy *et al.* 2010, p. 285). However, the period of time that spruce plantations may support high hare densities in Maine and eastern Canada may be relatively short (10 to 17 years post-harvest) compared to regenerating softwood clearcuts (15-35 years post-harvest)(Simons-Legaard *et al.* 2013, p. 569).

Under certain forest stand conditions, herbicide treatment may have long-term effects on stand composition and structure (MacLean and Morgan 1983, Daggett 2003), thus reducing food, cover, and habitat for hares (Borrecco 1976, Bellefeuille *et al.* 2001, p. 43, Thompson *et al.* 2003 p. 462). Understory deciduous stems were lacking in stands treated with herbicide (Homyack *et al.* 2004). Although herbicide treatments reportedly do not directly affect survival, fecundity, or other demographic parameters of snowshoe hares (Sullivan 1996), treatments have indirect effects on hares via changes in vegetative cover and browse (Homyack *et al.* 2005, p. 10). In Norway, hares use of plantations was reduced up to 10 years after herbicide application (Hjeljord *et al.* 1988).

Fragmentation - Lynx achieve highest densities in >100 km2 landscapes having a high percentage of large, contiguous patches of high quality hare habitat (Simons 2009, Simons-Legaard *et al.* 2013). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges, by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that land-scapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Forest management can fragment and isolate patches of high quality hare habitat (Simons-Legaard *et al.* 2016). In an intensively managed landscape, lynx habitat is described as a shifting mosaic of patches of habitat suitable to support the needs of resident lynx (FR 74(36)). Fragmentation of the naturally patchy pattern of lynx habitat in the contiguous U.S. can affect

lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation from forest management can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. For example, in Maine the proliferation of partial harvesting will actually increase the patches of high quality hare habitat by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6).

Changes in Frequency and Pattern of Disturbance Events - Prior to European settlement, the dominant natural disturbance processes that created early-successional stages within the range of the lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of the Northeast Geographic Unit, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S.

Today, forest management is the predominant form of disturbance in boreal forest types throughout the DPS, but in the West insect outbreak or wildfire are also critical agents of disturbance that influence and interact with forest management. Throughout the DPS, the frequency of harvesting accelerates in response to salvaging insect damaged stands. In some instances, forest management has greatly altered the disturbance regime. For example, the Acadian forest in Maine and eastern Canada was driven by gap dynamics (similar to some parts of the West today) and true stand-replacing disturbances were quite uncommon with recurrent intervals of thousands of years. After several centuries of forest management, stand age structures have become simplified, and commercial timber rotations are a fraction (15 to 40 percent) of the lifespan of boreal tree species (Seymour 2002). Whereas prevalent, these younger even-aged forest stands on the landscape may benefit hares and lynx in Maine, forestry has shifted the species composition of Maine's forest to species favored by frequent harvest disturbance, such as red-maple, paper birch, aspen, and balsam fir.

3.4 Wildland Fire Management

Wildfire is a natural and essential component of boreal and montane forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger *et al.* 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Wildfire creates and maintains lynx habitats by providing periodic vegetation disturbances that result in the spatial and temporal distribution of early-successional forest stands or patches within older stands featuring dense horizontal cover at ground and snow level. These stands/patches provide high-quality hare foraging habitat and typically support high densities of hares, which in turn provide high-quality lynx foraging habitat.

They are generated by (1) high-intensity, stand-replacing fires that result initially in removal of all or most vegetation, followed by regeneration of dense horizontal cover, or (2) low- or moderate-intensity fires that stimulate understory development in older stands without killing all the overstory, resulting in patches of dense horizontal cover within multi-storied stands (Agee 2000, p. 53; Ruediger *et al.* 2000, p. 7-6). These habitats become most favorable for hares and lynx when regenerating conifers grow tall enough to protrude above the snow, providing cover and food for hares throughout the winter (ILBT 2013, pp. 10-12). They remain important as winter foraging habitat, which may be the most limiting habitat for lynx (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 17, 27), until they reach the stem-exclusion structural stage and self-pruning results in the loss of dense horizontal cover above the snow, or until another disturbance resets them to the stand-initiation structural stage (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 1-3; ILBT 2013, p. 27). The length of time to achieve favorable hare and lynx habitat after fire (or other vegetation disturbance) and the duration for which those conditions persist vary across the lynx range depending on soil and vegetation potential, temperature and precipitation patterns, topography, fire intensity, and perhaps other local conditions (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 2-5; ILBT 2013, pp. 27-29, 75). Generally, regenerating forests in the DPS range may begin providing winter hare habitat within 10-20 years after fire or other disturbance, with favorable conditions persisting for 20-30 years after that (Koehler and Aubry 1994, pp. 86-87; Agee 2000, pp. 67-71; Fuller *et al.* 2007, p. 1985; McCann and Moen 2011, p. 515; Vashon *et al.* 2012, p. 15; ILBT 2013, pp. 28-29), although it may take longer, perhaps 35-40 years, for lynx habitat to recover in some parts of the range (e.g., Maletzke *in* Lynx SSA 2016, p. 21).

Fire frequency, size, intensity, and return intervals also vary across the range of the lynx and depend on localized vegetation communities, climatic conditions, and topography (Agee 2000, pp. 47-56; Ruediger *et al.* 2000, p. 4-8; ILBT 2013, pp. 75-76). In lynx habitats, fire intensity is typically high and fire return intervals long but variable, with large areas affected by infrequent stand-replacing fires and, in mixed fire regimes, moderate- or low-intensity fires in the intervals between stand-replacing events (Agee 2000, pp. 49-54; Ruediger *et al.* 2000, pp. 4-8, 7-6). Within the DPS range, fire return intervals in the Great Lakes Region appear similar to those in the core of the lynx's range in the Canadian and Alaskan taiga (roughly 50-150 years), with longer return intervals in Western (150-300 years) and Northeastern (up to 500 years) U.S. forests (Agee 2000, pp. 52-53; ILBT 2013, pp. 75-76). Despite these long intervals, fire is the dominant natural disturbance mechanism in lynx habitats in the DPS range except in the Northeast, where insects and wind are more important (Agee 2000, p. 53).

Current federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI *et al.* 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Calkin *et al.* 2015, pp. 1-3) which, combined with other land-use practices, dramatically altered fire regimes in some places and created conditions prone to larger and more severe fires (USDI *et al.* 2001, p. 1-2). Because of (1) fire's important role in creating and maintaining high-quality early-successional hare habitat in most lynx habitats in the contiguous

U.S., (2) the potential for fire suppression to alter this dynamic to the detriment of hares and lynx, and (3) the limited ability of land managers (at that time) to use fire to benefit hares and lynx, wildland fire management was identified as a "Lynx Risk Factor Affecting Lynx Productivity" (Ruediger *et al.* 2000, pp. 2-5, 5-2). To address these concerns, the authors developed objectives, standards, and guidelines for federal land managers to restore fire's role in maintaining lynx habitats, attempt to mimic historic natural fire regimes, and integrate lynx habitat objectives into fire management plans (Ruediger *et al.* 2000, pp. 7-6 - 7-8). They also directed federal land managers to evaluate whether fire suppression or other management practices had altered fire regimes and ecosystem function in potential lynx habitats and, where so, to use fire (naturally ignited fires or prescribed burns) as a tool to restore and maintain lynx habitat by creating or regenerating snowshoe hare habitat (Ruediger *et al.* 2000, p. 7-7).

In its 2000 listing rule and 2003 remanded determination, the Service recognized the potential for fire suppression to adversely affect lynx and hare habitats at local and regional scales, particularly in the Great Lakes Region, where fire suppression policies across land ownerships likely prevented fire from assuming its natural role in creating a landscape mosaic of vegetation communities and age classes (65 FR 16076; 68 FR 40095). In the Northeast, the Service concluded that the very long fire return intervals and maritime influence in lynx forest types indicated that fire did not historically play a significant role in creating or maintaining lynx and hare habitats and, thus, fire suppression was unlikely to have affected lynx habitat (68 FR 40094). In the West, the Service concluded that the effects of fire suppression were likely lower in lynx forest types because of their typically long fire return intervals compared to lower and drier forest types (65 FR 16074; 68 FR 40093-94). Overall, the Service concluded that fire suppression did not represent a threat to lynx in the Northeast and was a low-magnitude threat in Great Lakes, S. Rockies, and N. Rockies/Cascades (65 FR 16075-16076; 68 FR 40093-40098).

In response to the guidance provided in the LCAS, the USFS, when developing the NRLMD and the SRLA to amend forest plans to address lynx conservation (see 3.1.1, above), evaluated whether fire suppression had adversely affected potential lynx habitats on national forests in the Northern and Southern Rockies. The USFS concluded that many forests in potential lynx habitat are in Condition Class 1, which means they have not missed a fire cycle because large, stand-replacing fire only occurs every 100 to 200 years; the long fire return interval has not been affected to any large degree by more recent fire suppression as is the case in drier forests with short fire return intervals; and they are close to historic conditions (USFS 2007, pp. 18, 20; USFS 2008, p. 11). In addition to the national forests covered by the NRLMD and SRLA (all national forests in the Northwestern Montana/Northeastern Idaho, GYA, and Western Colorado SSA units), the Superior National Forest, which accounts for 45 percent of the Northeastern Minnesota unit, revised its forest plan to adopt lynx conservation measures consistent with the LCAS (USFS 2004, Appendix E). The Okanogan-Wenatchee National Forest in the North-central Washington unit is currently revising its management plan and continues to manage for lynx conservation in accordance with the LCAS, including direction to restore fire to its natural ecological role and to use it as a tool to restore and maintain hare and lynx habitats.

As described above in section 3.1.1, current federal management on most USFS and BLM lands, in accordance with formally revised or amended management plans, includes limits on the proportion of lynx habitat within LAUs that can be in an unsuitable condition at any given time, including such conditions, usually temporary, created by wildfire. Although some exemptions and exceptions to these limits are permitted for activities to reduce fire risks to communities and infrastructure in the wildland-urban interface (WUI) or to achieve other resource benefits, even these potential impacts are limited on the larger landscape scale (USFWS 2007, p. 7). These conservation measures and the direction to use fire management as a tool to restore hare and lynx habitats and return to natural temporal and spatial patterns of fire disturbance, which were not in place when the DPS was listed, likely further reduce what was even then considered the low potential threat to lynx of past fire suppression activities. Based on the information above, we conclude that fire suppression and other fire management activities have not substantially impacted lynx and hare habitats in the DPS range and are unlikely to do so in the future.

However, warming temperatures attributed to climate change are reducing snowpack, causing earlier snowmelt and longer and more extensive droughts, resulting in longer wildfire seasons and increased fire frequency, size, and intensity in boreal forests of the north and in boreal and montane forests in some parts of the DPS range (Weber and Flannigan 1997, entire; Stocks *et al.* 1998, entire; Gillett *et al.* 2004, entire; Kasischke and Turetsky 2006, entire; Soja *et al.* 2007, entire; Pierce *et al.* 2008, entire; Flannigan *et al.* 2009, entire; Krawchuk *et al.* 2009, entire; Le Goff *et al.* 2009, entire; Bergeron *et al.* 2010, entire; Salathe *et al.* 2010, entire; Abatzoglou 2011, entire; McKelvey *et al.* 2011, entire; Abatzoglou and Kolden 2013, entire; Pederson *et al.* 2013, p. 1815; Price *et al.* 2013, pp. 342-343, 352-354; Barbero *et al.* 2014, entire; Trenberth *et al.* 2014, entire; Barbero *et al.* 2015, entire; Jolly *et al.* 2015, entire; Lute *et al.* 2015, entire; USEPA 2015, entire; Lienard *et al.* 2016, entire; Littell *et al.* 2016, entire; Westerling 2016, entire; see also section 3.2 above). Increases in fire frequency and size have the potential to adversely affect lynx and hare habitats in the DPS range by rapidly converting large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats (ILBT 2013, p. 70). Although this would likely be a temporary impact, with burned areas subsequently regenerating into higher-quality habitat, it would likely reduce landscape-level hare densities and, therefore, lynx numbers, potentially compromising an area's ability to support a resident lynx population until burned habitats recover.

Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already naturally marginal in many parts of the DPS range, it is possible that very large wildfires or many over a short time period could, perhaps in concert with other influencing factors, tip an area from just barely capable of supporting a resident lynx population to no longer capable of doing so, resulting in extirpation. For example, multiple large fires in north-central Washington over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). It may take 35-40 years for these areas to

recover as lynx and hare habitat (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and other habitat impacts could further diminish habitat availability and the lynx population's probability of persistence (Lewis 2016, pp. 5-6; Lynx SSA Team 2016, p. 44; also see section 2.3.2.2, above, and sections 4.1.4 and 5.1.4, below). The loss of habitat resulting from these fires and its potential demographic impacts on the State's only resident lynx population contributed substantially to the Washington Department of Fish and Wildlife's recent recommendation to uplist lynx from threatened to endangered under its State Endangered Species Program (Lewis 2016, entire).

Wildfire frequency, size, and intensity have also increased in the Northwestern Montana/ Northeastern Idaho geographic unit, where about 4,172 km^2 (1,611 mi^2; over 15 percent of the unit) have burned in western Montana from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20). Large fires have also impacted lynx habitat in the Western Colorado geographic unit, where fire size, frequency, and intensity are expected to increase with climate change (Ivan *in* Lynx SSA Team 2016, p. 23). As mentioned in section 2.3.2.2, large areas of the GYA unit were burned by the extensive wildfires of 1988. The extent to which those fires may have diminished lynx and hare habitats and contributed to the recent absence of resident lynx is uncertain, as is the potential for those burned areas to support high hare densities and resident lynx in the future. However, some burned areas may soon develop the dense horizontal conifer structure favorable for hares and, therefore, for lynx foraging habitat, perhaps increasing the likelihood that they may support resident lynx in the near future.

Although fire suppression was in the past thought to be a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

3.5 Habitat Loss and Fragmentation

Boreal forest habitats in the DPS are patchy and marginal for both snowshoe hares and Canada lynx. In this region, boreal forest transitions to various types of northern hardwood forest. The transitional nature of the boreal forest at its southern extent is believed (along with competition from other hare predators) to limit the numbers of both hares and lynx, preventing either from regularly achieving densities comparable to those regularly achieved in the classic boreal forests at the centers of their ranges in north-central Canada and Alaska (79 FR 54790). Lynx must contend with aspects of their habitat at the southern extent of the boreal forest for which they are not as well-adapted.

Fragmentation has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991). "Patchiness" is sometimes used to refer to natural processes (Buskirk *et al.* 2000a, p. 85), whereas and "fragmentation" to anthropogenic disruption of natural patterns. Habitat loss is conversion of forest to another land use or vegetative cover.

Forest loss and fragmentation are relatively low in the DPS compared to other forested regions in the United States (Heilman *et al.* 2002, p. 416). Since 2000 in the western United States, land uses associated with residential development, roads, and highway traffic have resulted in a 4.5% loss in area (20,000 km^2) of forest, and continued expansion of residential development will likely reduce forested patches by another 1.2% by 2030 (Theobold *et al.* 2011 (entire). Fragmentation in the forested western landscape resulted in a decline of weighted mean patch size from roughly 35,000 to 3,200 km^2 from natural to current conditions, but models predict relatively small declines in the size of forested patches over the next 30 years (Theobold *et al.* 2011 p. 2451). In the eastern United States, nearly half or more of the natural forest was cleared in the past three centuries but as agriculture and settlement relocated westward, eastern forest cover rebounded (Williams 1989, Smith *et al.* 2005). Maine's forest area has increased 0.79 percent since 1982 (Maine Forest Service, Department of Conservation 2010, p. 25). Similarly, a large portion of Minnesota forests were cleared in the last century, but forest cover has rebounded. The forest area in northern Minnesota has decreased 4 percent since 1977 (Miles *et al.* 2007, p. 22). Preliminary findings from the 2002 U.S. timber assessment (Haynes 2003) indicate that approximately 15 to 20 million acres of U.S. forest land could be converted to urban and developed uses over the next 50 years. Such land use conversions could result from residential development in forested landscapes, as the U.S. population is estimated to grow by another 126 million people.

Habitat fragmentation (both natural and anthropomorphic) directly affects snowshoe hares and lynx by various mechanisms; reducing hare survival and landscape hare densities, increasing lynx home ranges, reducing lynx reproduction and survival, and affecting lynx movements throughout the landscape. Habitat fragmentation also influences mesocarnivore communities that coexist with lynx and the level of competition for space and food resources. Fragmentation from anthropomorphic sources results in habitat alteration, direct habitat loss, vehicle collisions and behavioral disturbance from roads, and changes in landscape features such as edges.

Landscapes in which hare habitat is more contiguous, or where good patches of hare habitat are surrounded by other patches of similar habitat quality, support more hares than landscapes that are more fragmented or include matrix habitats that are poorer quality (Lewis *et al.* 2011, p. 565). Thus, southern transitional boreal forests generally have lower landscape snowshoe hare densities than boreal forests further north (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84). This may have as much to do with the quality of the matrix habitat between high quality patches as the hare densities that occur in the high quality patches themselves (Lewis *et al.* 2011). Low-quality matrix habitat, typical throughout much of the DPS, could decrease survival for hares, because predators might have higher hunting success or be more numerous in the matrix habitats (Griffin and Mills 2009). In contrast, a high-quality matrix, typical of Canadian boreal forest, can provide alternative or supplemental resources (Dunning *et al.* 1992; Norton *et al.* 2000), thus supporting higher densities of hares in the prime habitats.

The patchy distribution of hares and differences between landscape hare densities in the contiguous United States require lynx in most areas to incorporate more land area into their home ranges than lynx do in the north to acquire adequate food (Mowat *et al.* 2000, pp. 265, 277–278). At some point, landscape hare densities become too low, making some areas incapable of supporting lynx. Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range.

Throughout the northern part of their range, snowshoe hares are found in continuous areas of boreal forest; conversely, southern populations occur primarily in insular patches of suitable habitat set amidst less-preferred areas (Wolff 1980; Keith *et al.* 1993). This disparity has led a number of biologists to speculate that habitat fragmentation may be ultimately responsible for the non-cycling nature of snowshoe hare populations in the northern U. S. and southern Canada (Dolbeer and Clark 1975; Buehler and Keith 1982; Keith *et al.* 1993, Strohm and Tyson 2009). Wolff (1980, 1981) described the mechanism by which a fragmented habitat might dampen or eliminate cyclic population fluctuations.

Forest fragmentation may exacerbate competition between lynx and other predators (Buskirk *et al.* 2000a, entire). Fragmentation and competition are strongly linked because vegetation mosaics in landscapes provide high quality environments for generalist species such as the bobcat, red fox, and coyote (Goodrich and Buskirk 1995, Buskirk *et al.* 2000a, p. 84). Under such conditions, generalist predators tend to dominate the predator guild in fragmented landscapes (Oehler and Litvaitis 1996). Hares fluctuate less dramatically in the southern part of the range of lynx, thus there is more competition for a limited resource and exploitation competition inflicted by generalists (e.g., coyotes) and other predators (Buskirk *et al.* 2000a, p. 95).

Snowshoe hares in the south are concentrated in isolated patches of suitable habitat and subject to predation by a suite of generalist predators (e.g., Litvaitis *et al.* 1985; Sievert and Keith 1985; Keith *et al.* 1993; Cox *et al.* 1997). Keith *et al.* (1993) found that extremely high predation rate on hare living in high quality hare habitats, rather than predation on naturally dispersing individuals, seemed to be driving the changes in distribution and abundance in a snowshoe hare population in Wisconsin. In this study, predation pressure on populations occupying small (<7 ha) patches of preferred habitat was so severe that 3 of the 5 populations under investigation went extinct in the course of the 3-year study. Fragmentation of landscapes exacerbate the effect of predation by allowing carnivores to concentrate their hunting efforts on small patches of habitat used by their preferred prey instead of preying disproportionately on dispersing individuals (Wirsing *et al.* 2003, p. 170). In predator-rich landscapes characteristic of the DPS, this can result in intense predation and competition for a limited prey resource.

Lynx seem to be flexible in their response to habitat fragmentation whereas closely related species, such as bobcats and Iberian lynx, are sensitive to habitat fragmentation (Ferreras 2001, Crooks 2002). In a southern Ontario landscape Hornseth *et al.* 2014 (pp. 8-9) demonstrated that lynx exhibited a wide range of responses to habitat alteration. In general, lynx

responded most positively to areas having greater than 50 percent suitable habitat and generally avoided areas having less than 30 percent suitable habitat. However, lynx showed no sensitivity to the degree of forest fragmentation in areas of high or low suitable habitat.

All of these factors likely lead to lower reproductive output and more tenuous conservation status for lynx in many parts of the DPS relative to those in Canada and Alaska (Buskirk *et al.* 2000a, p. 95). Thus, factors that further fragment boreal forests in the DPS (e.g., climate change, forest management, roads and development) further reduce the probability of persistence of lynx.

The snow environment in the DPS is also patchy and marginal in both space and time for snowshoe hares and Canada lynx. Snow depth (Hoving *et al.* 2005, Peers *et al.* 2013, entire) and duration (Gonzales *et al.* 2007) give lynx a competitive advantage over generalist predators in the conterminous United States. Too little snow or crusting conditions favor competitors and predators like bobcat, fisher, and coyotes. High elevations may provide snow conditions that favor lynx, whereas low elevations favor conditions for competitors. Lynx may have competitive advantage at higher elevations in the DPS in the winter, but not in summer months when competitors may have free access to all habitats. In contrast, extensive deep, fluffy snow conditions favor lynx in broad areas of north-central Canada and Alaska.

Landscape features further fragment hare and lynx habitat. In lynx units in the western contiguous U.S., potentially suitable boreal forests and appropriate snow conditions occur in relatively narrow elevational bands in the Cascade and Northern and Southern Rocky mountains. Thus, appropriate habitats for lynx are naturally fragmented by topography and vegetation gradients. These “islands” of habitat can be extensive (e.g., the Okanagan in Washington or most of northwestern Montana) or smaller and relatively isolated (e.g., the Garnet Range in western Montana) depending on topography and precipitation patterns. Some of these areas of boreal forest are separated by unsuitable habitats in the low valleys (e.g., sage flats, urban corridors, agricultural lands) or by snow regimes (e.g. snow shadows) that may restrict lynx dispersal between habitat patches. In some western parts of the DPS range, lynx habitat in is also fragmented by rugged, high elevation terrain (Carroll *et al.* 2001, p. 976). In other areas of the DPS where there is little topography, including Minnesota and Maine, matrix forest facilitates lynx movements between suitable habitats. Large rivers are unlikely to fragment habitat as lynx readily swim across large bodies of water (Feierabend and Kielland 2014, entire) or cross them on ice in the winter (Koen *et al.* 2015).

Snow is an important component of lynx habitat (79 FR 54809). Snowfall can be patchily-distributed, variable and unpredictable from year to year, and affected by local topography, water bodies, and climate gradients. Snow conditions that provide lynx a competitive advantage over other terrestrial hare predators are most consistent in the high-elevation regions of the western U.S., although snow alone does not constitute lynx habitat (i.e., many places receive sufficient snow but lack other features lynx need, typically adequate hare densities). Snow conditions are less consistent in the East. For example, lake-effect snow from Lake Superior can increase snow depth and duration in the Arrowhead region of Minnesota in some years, but

not others. The Gulf of Maine has the reverse effect, and its warming influence reduces snow depth and duration inland. Distribution models by Hoving (2001, p. 74) indicate that eastern Maine has extensive areas of boreal forest but does not achieve snowfall thresholds that gave lynx an advantage over bobcats and other competitors.

Lynx populations are clearly most viable in areas having extensive, unfragmented boreal forest habitats with large patches of high-quality foraging habitat and persistent deep, fluffy snow. Both lynx and hares are influenced by the spatial arrangement of preferred habitat. In Ontario, lynx preferred habitats with a high degree of connectivity (Walpole *et al.* 2012, p. 769). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Several studies (Koehler 1990a, Mowat *et al.* 2000, von Kienast 2003, Maletzke 2004, Squires and Ruggiero 2007, Squires *et al.* 2010) have reported that lynx avoid large openings, especially during winter. Mowat *et al.* (2000) suggested that relatively few snowshoe hares use large openings, and consequently lynx spend little time hunting in these areas. Koehler (1990a) speculated that vegetation management prescriptions that result in distance to cover >100 m (328 ft) may change lynx movement and use patterns until such time as sufficient reestablishment of forest vegetation occurs. Opening size can also influence seedling regeneration and stocking densities (Kreyling *et al.* 2008).

Similarly, individual lynx have the smallest home ranges and greatest survival and productivity in landscapes that have extensive, large patches of habitat in combination with deep, fluffy snow. Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that landscapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Anthropogenic Sources of Fragmentation - Human activities can exacerbate the natural habitat fragmentation that is typical throughout much of the DPS range. Anthropogenic activities such as forest management, development, and highways alter natural landscape patterns. They cumulatively can reduce the total area of habitat, diminish the quality of habitat, increase the isolation of habitat patches, and impair the ability of lynx and other wildlife to effectively move between patches of habitat. Anthropogenic fragmentation may be permanent, for example by converting forest habitat to residential, industrial, or agricultural purposes, or temporary, for example by conducting forest management but allowing trees and shrubs to regrow. Habitat fragmentation (both natural and anthropogenic) increases the risk of extirpation of small lynx populations.

Human-caused fragmentation of the already naturally patchy pattern of lynx habitat in the contiguous U.S. can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. Maintaining a mosaic of large (>100 acres) patches of young to old stands in patterns that are representative of natural ecological processes and disturbance regimes would be conducive to long-term conservation of lynx (ILBT 2013, p. 77).

Roads, development, climate change, and forest management fragment snowshoe hare and lynx habitat in the DPS. We know little about how hare and lynx respond to these anthropomorphic changes to their habitat, which requires additional research (Murray *et al.* 2008, p. 1464; Squires *et al.* 2013, p. 194). In the next decades, southern lynx populations will incur further habitat loss and fragmentation and the effects of climate change. Changes in habitat, prey base, and competitor guild will further stress southern lynx populations and possibly populations in southern Canada. Ultimately, the extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in its current southern range (Murray *et al.* 2008, p. 1469).

Roads - Paved highways fragment lynx habitat. In the West, they typically follow natural features such as rivers, valleys, and mountain passes that may have high value for lynx in providing habitat or connectivity. They surround large blocks of lynx habitat in Minnesota and northern Maine. Various studies have documented lynx crossings of highways. A male lynx in western Wyoming was documented to have successfully crossed several 2-lane highways during exploratory movements (Squires and Oakleaf 2005). However, in Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx (Bayne *et al.* 2008). Apps *et al.* (2007) found lynx were 13 times less likely to cross the Trans-Canada Highway relative to random expectation, but only 2.2 and 3.1 times less likely to cross smaller highways (93 and 1A, respectively). In southeastern British Columbia, lynx avoided crossing highways within their home ranges (Apps, 2000). Squires *et al.* 2013 (p. 194) documented 44 radio-collared lynx with home ranges within an 8 km buffer of 2-lane highways, however, only 12 of these individuals crossed the highway (Squires, unpublished data).

Paved highways also pose a risk of direct mortality to lynx and may inhibit lynx movement between previously connected habitats. If lynx avoid crossing highways, this could lead to a loss of effective habitat within a home range and reduced interaction within a local population (Apps *et al.* 2007). Lynx and other carnivores may avoid using habitat adjacent to highways, or become intimidated by highway traffic when attempting to cross (Gibeau and Heuer 1996, Forman and Alexander 1998).

Carnivores are especially vulnerable to highway-caused mortality in areas with dense and high traffic volume roadways (Clevenger *et al.* , 2001). As the standard of roads increases from gravel to 2-lane or 4-lane highways, traffic volumes and the degree of impact are expected to increase. Walpole *et al.* (2012, p. 770) found that small logging roads with low traffic volume had no effect on lynx distribution. Four-lane highways, such as the interstate highway system, commonly have fences on both sides, service roads, parallel railroads or power lines, and impediments like "Jersey barriers" that make successful crossing more difficult, or impossible, for wildlife (ILBT 2013, p. 78). Alexander *et al.* (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. In Colorado, lynx successfully and repeatedly crossed major highways, including I-70 (J.Squires, personal communication 2012; Ivan 2011b, c, 2012). Colorado lynx crossed two-lane highways an average of 0.6 times per day and more frequently during dusk and night when traffic volume was lower (Baigas *et al.* 2017, p. 204). They also crossed 4-lane highways (I-70), especially forested areas under large, elevated bridges that spanned streams (Baigas *et al.* 2017, p. 204).

Between 2000 and 2015, 54 lynx were reported to have been killed on roads (both paved and unpaved) in Maine (J. Vashon, Maine Department of Inland Fisheries and Wildlife, unpub. data), 11 in Minnesota (T. Smith, U. S. Fish and Wildlife Service, unpub. data), 1 in Idaho and 5 in Montana (compiled by K. Broderdorp, U.S. Fish and Wildlife Service, unpub. data 2016). Between 1995 and 2011, 15 lynx were reported killed on British Columbia highways (British Columbia Wildlife Accident Reporting System 2012). Most of these mortalities are on higher speed paved highways. However, in Maine, about 41 percent (22 of 54) were killed on lower speed dirt logging roads.

Translocated animals may be more vulnerable to highway mortality than resident lynx (Brocke *et al.* 1990), because they often move extensively after their release and are unfamiliar with their surroundings. In the Adirondack Mountains of New York, an attempt to reintroduce lynx failed and 18 of 37 mortalities of translocated animals were attributed to road kills (Brocke *et al.* 1990). Over a 7-year period in Colorado, 13 of 102 documented mortalities of translocated lynx were killed on highways (Devineau *et al.* 2010). Traffic volumes on Colorado highways where the 13 lynx mortalities occurred were estimated to range from about 2,300 to >25,000 vehicles per day (K. Broderdorp, personal communication 2012).

Roads of all sizes have many indirect effects to lynx including increased human access (e.g. trapping and illegal shooting), and creating edge habitats that promote co-occurrence with competitors like coyotes and bobcats (Bayne *et al.* 2008, p. 1195).

Vegetation Management - As described in section 3.3, above, forest management can further fragment boreal forest in the northern contiguous United States affecting habitat suitability for both snowshoe hares and lynx. Large-scale forest fragmentation or maturation can be deleterious to snowshoe hares because they become increasingly restricted to small patches with adequate cover, and higher predation rates from a variety of carnivores tend to increase

local extinction risk (Wolff 1981, Keith *et al.* 1993, Wirsing *et al.* 2002; see also Barbour and Litvaitis 1993).

Although some forest management can benefit lynx by creating or maintaining a shifting mosaic of lynx habitat, it can also be detrimental by fragmenting habitat into small, widely-spaced parcels. Changes to vegetation structure can increase landscape resistance to lynx movements (Squires *et al.* 2013). In Montana, fragmentation from forest thinning decreased the probability of lynx movements across the forested landscape (Squires *et al.* 2013, p. 192). Lynx in the Northern Rockies are sensitive to changes in forest structure and tend to avoid large forest openings (Koehler, 1990; Squires *et al.* , 2010) like recent clearcuts and thinned areas. In Maine, the shift to partial harvesting forms of forest management will continue to increase the number of patches of high quality hare habitat, but it will greatly reduce the size of patches and increase their isolation (Simons-Legaard *et al.* 2016, pp. 5-6). This is diminishing landscape conditions conducive to supporting lynx.

Residential and Commercial Development - Residential and commercial development is increasing on private forest lands. Increased traffic and urbanization are projected for the Northern Rockies (Hansen *et al.* 2002) and Maine (section 5.1.1). It is uncertain to what degree lynx can tolerate habitat fragmentation from roads and forest clearing, and how human and pet activity affect lynx use of habitats. Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat *et al.* 2000). The degree to which residential development and associated roads reduce connectivity of mesocarnivore populations (including lynx) likely depends on the physical design of highway improvements, the surrounding environmental features, the density of increased urbanization, and the increased traffic volume (Clevenger and Waltho, 2005; Grilo *et al.* 2009).

Ski Resorts - Ski areas have similar effects on permanent habitat loss and fragmentation. One ski run is often separated from the next only by small inter-trail forest islands. Ski runs often are intermixed with other open areas such as open or gladed bowls, rock outcrops, or barren tundra ridges. Ski resorts that are built or expanded in lynx habitat may impact lynx by removing forest cover, reducing the snowshoe hare prey base, and creating or increasing human disturbance in or near linkage areas. There is limited information on lynx behavior and habitat use in and around ski areas. Lynx have been known to incorporate smaller ski resorts within their home ranges, but may not utilize the large resorts. Preliminary information from an ongoing study in Colorado suggests that some recreational use may be compatible, but lynx may avoid some areas with concentrated recreation use. In some areas, lynx habitat may be limited and concentrated in the ski area development footprint (J. Squires, personal communication 2012).

More than 50 ski areas exist throughout the range of the lynx in the contiguous U.S. (ILBT 2013, pp. 82-83). Most ski areas are located on north-facing slopes, where ample snow conditions provide for extended ski/snowboard recreational seasons. In the western states, many of these landscapes feature spruce-fir forests. While ski resorts occupy a small proportion of the landscape, spruce-fir forests provide important habitat for snowshoe hares and lynx at the

southern extent of their range. In winter, alpine and Nordic skiing and snowboarding are the primary uses. Most of these resorts offer year-round recreation, with summer activities typically including hiking and mountain biking.

Mining Leasable Minerals - Activities associated with exploration and development of leasable minerals occur primarily in western units of the DPS. Very little mining development occurs in Minnesota and northern Maine. Mining affects lynx habitat by changing or eliminating the native vegetation, human disturbance, and contributes to habitat fragmentation. Development of a high density of wells, as is typical of coal-bed methane development (e.g., 1 well per 2–4 ha [5–10 ac]), could affect lynx by directly removing habitat or causing sufficient human presence to displace lynx. The development of associated roads, powerlines, and pipelines to facilitate exploration and development also result in a loss of lynx habitat and contribute to fragmentation of habitat. In some areas, for example in the Wyoming Range, extensive oil and gas development is occurring within lynx habitat.

Locatable Minerals - Only a fraction of the historical number of mines is operating today. Those that continue to operate do so with more stringent environmental protection measures. However, in some parts of the United States, minerals exploration and new development seem to be increasing. Activities associated with exploration and development of locatable minerals could affect lynx habitat by changing or eliminating the native vegetation, and by contributing to habitat fragmentation. The effects can be variable depending on the size of the associated mining operation or development. Locatable minerals are extracted through both open pit and sub-surface mines with potential habitat alteration ranging from tens to thousands of hectares. In some instances, such as larger mining operations, land exchanges are conducted to consolidate private ownership of the surface above a deposit prior to mine development. Depending on lands exchanged this could retain lynx habitat in public ownership, but could still result in a net loss of habitat. Development of road and railroad access to facilitate exploration and development also directly impact lynx habitat, contribute to fragmentation, facilitate increased competition as a result of snow-compacted routes, and result in direct mortality. Despite these potential effects, mining exploration and development is generally anticipated to affect only a small portion of lynx habitat in the contiguous United States.

Salable Minerals - In general, salable minerals are found close to the surface. During exploration activities, equipment is moved to the site and a number of test pits are dug or holes drilled to determine the quality of material. If desired minerals are found in suitable quantity, then vegetation is removed and materials are excavated. For example, gravel pits are needed for logging road development and maintenance and are common occurrences throughout areas of the DPS that are in active forest management. Areas developed for salable minerals can vary in size from a single truck load to tens of acres. Impacts to lynx include the potential alteration or removal of lynx habitat, increased fragmentation, and the potential for human-caused mortality from road development.

Wind Energy - Wind energy development and associated transmission lines in lynx habitat is increasing across the nation. Facilities are located on ridge tops or other areas exposed to

consistent wind. The construction of wind facilities including access roads may result in loss of lynx habitat and increased fragmentation from permanent forest clearings. Noise and human activity associated with the construction and operation of wind facilities could disturb or displace lynx from important habitats. Effects would likely continue through the life of the project, which may exceed 20 years.

Utility Corridors - Utility corridors contain developments such as overhead or buried powerlines and gas pipelines, and often are located within or adjacent to existing road rights-of-way. Utility corridors potentially could have short- or long-term impacts to lynx habitats, depending on location, type, vegetation clearing standards, and frequency of maintenance. Those that are extensively cleared of vegetation and maintained in grass or herbaceous vegetation likely equate to a permanent habitat loss. When associated with highways and railroads, utility corridors may further widen the right-of-way. Utility corridors may facilitate human access into previously remote areas thus exposing lynx to increased trapping and possible illegal shooting.

Agriculture - Agricultural activity is not expanding currently in lynx habitat areas in the DPS range. In fact, in the late 1800s, over 3 million acres of northern Maine was in farming, compared to about 700,000 acres today (Ahn *et al.* 2002, p. 8). Most of the current farming is in northeastern Maine, where it fragments the forested landscape corridor between core habitats in northern Maine and western New Brunswick, Canada. Forest clearing for agriculture may have contributed (along with increasing road densities and an expansion in coyote distribution) to the recent contraction in the southern part of lynx range in eastern Alberta (Bayne *et al.* 2008, p. 1195).

Habitat Loss and Fragmentation in Corridor Areas Connecting Lynx Populations in the DPS with Adjacent Populations in Canada - Lynx conservation in the contiguous U.S. is thought to depend in part on maintaining connectivity with habitat areas and lynx populations in Canada. Maintaining connectivity for lynx may become increasingly difficult because of climate change and other anthropogenic influences, as evidenced by reduced connectivity for other boreal species (van Oort *et al.* 2011). Potential corridors have been identified in the northern Rockies (Squires *et al.* 2013, entire). There are likely broad, forested corridors with suitable dispersal habitat connecting core habitats in Maine to southern Quebec and northern Minnesota to southern Ontario. Given the perceived importance of lynx immigration from Canada to the persistence of the DPS (FR 68 40076– 40101, Squires *et al.* 2013, p. 187), roads and other forms of habitat loss and fragmentation that may impede lynx movements in the border regions of Canada and the U.S. are of concern.

Chapter 4: Current Conditions

In this chapter, we present our understanding, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the current status of the lynx DPS in terms of redundancy, representation, and resiliency. . We then provide brief summaries of the current conditions in each geographic unit, followed by a more detailed evaluation of the status of lynx populations and habitats and the factors currently believed to

influence them in each unit. Where appropriate, we compare our current understanding to what was known or believed when the DPS was listed under the ESA in 2000 and to our understanding of historical conditions.

4.1 Summary of Current Conditions DPS-wide

Because of the limitations and uncertainty in the historic records of lynx occurrence in the contiguous U.S. (described above in section 2.3.2.1), it is difficult to compare the current distribution and status of resident lynx populations in the DPS with what may have been the historical condition (but see evaluation in section 2.3.2.2, above). However, research and surveys over the last two decades have significantly improved our understanding of the current distribution, habitats, and the status of resident populations compared to what was known when the DPS was listed in 2000. For example, although we knew there were some resident lynx in Maine (Unit 1), we did not have a feel for population size or trend. We now know that northern Maine currently supports the largest resident population in the DPS, that extensive clear-cutting in the 1970s and 1980s in response to a large spruce budworm outbreak has created the current abundance of high-quality lynx habitat, and that there are many more lynx in Maine now than was likely under historic natural disturbance regimes and habitat distributions. Similarly, when the DPS was listed, we were uncertain whether Minnesota (Unit 2) supported a resident population. We now know that a persistent population occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. (Units 3, 4, 5, and 6) are naturally less abundant and more patchily-distributed than was thought at the time of listing, and several areas thought to have historically supported small resident populations currently do not (the GYA [Unit 5], the Garnet Mountains in western Montana [Unit 3], and the Kettle Mountains of northeastern Washington). We also know that recent extensive wildfires in north-central Washington (Unit 4) have reduced (probably temporarily) the amount of high-quality lynx habitat and likely caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado (Unit 6), although the current number of lynx there is unknown and their distribution uncertain.

With regard to redundancy, defined as the ability of the DPS to withstand catastrophic events, we find that the current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southern Colorado. Resident breeding lynx populations currently occupy five of the six geographic units (all but the GYA; Figure 1). Of the five occupied units, four are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2) (see tables 1, above, and 4, below). Lynx experts indicated no catastrophic event that could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS and, further, no or a very low likelihood of functional extirpation of any of the individual geographic units due to a single catastrophic event (Lynx SSA Team 2016, p. 56).

Because we lack evidence that persistent lynx populations have been lost from any other large geographic areas in the contiguous U.S., it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. That is, the loss of resident lynx populations in the DPS, to the extent suggested by verified historic records, was likely in areas (e.g., northern New Hampshire, Michigan's Upper Peninsula, the Kettle/Wedge area of northeastern Washington, perhaps Isle Royale in Lake Superior) peripheral to the geographic units that currently support resident lynx. Any small populations that were lost were not in large, discrete geographic units that would have represented substantially greater redundancy in the contiguous U.S. However, the implications of the potential recent loss of resident lynx in the GYA for the redundancy of the DPS are unclear. The historic record and recent research show that the GYA has supported resident lynx. However, it is unclear whether the area consistently supported a resident breeding population over time or whether it naturally supported resident lynx only some of the time ("winked on" in a metapopulation sense) when habitat conditions and hare densities were favorable, and at other times, when habitats and hare densities were less favorable, it did not support resident lynx ("winked off" in a metapopulation sense). Given the protected conservation status of millions of -acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. If so, the contribution of the GYA to redundancy within the DPS is questionable.

Representation, defined as the ability of the DPS to adapt to changing environmental conditions, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Lynx experts and geneticists indicated high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Although hybridization with bobcats has been documented in the DPS (in Maine and Minnesota), it is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Further, despite differences in forest community types and other habitat parameters (e.g., topographic/elevation settings) lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Therefore, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. Because there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions, we find that the DPS currently displays an adequate level of representation.

Resiliency, the ability to withstand stochastic disturbance events, is currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. However, because we lack reliable estimates of the sizes and

trends of most lynx populations in the DPS, we are unable to use these parameters to evaluate the current resiliency of individual populations or geographic units. Although some demographic data (survival, reproductive rates) are available for each geographic unit (see Table 3, below), they were collected using different methods, at different times and for different intervals, and possibly at different points in hare population cycles or fluctuations and, therefore, do not provide a consistent measure of resiliency. Efforts to understand resiliency within the DPS are also confounded by the metapopulation structure thought to govern lynx populations at the southern margin of their continental range, which suggests that some populations may be naturally ephemeral (i.e., “winked on” when conditions are favorable; “winked off” when conditions are not favorable). The related uncertainty about the extent to which DPS populations may rely on cyclic immigration of lynx from Canada during population irruptions and the ambiguity in the historic record that limits our understanding of the relative persistence of lynx in various geographical areas also limit our ability to characterize, rank, or model the relative contribution of each geographic areas to the resiliency of the DPS.

Despite uncertainties and data deficiencies, qualitative factors provide some hints about current relative resiliency among some geographic areas or parts of them. For example, in Maine, lynx appear to have demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the possible extirpation of lynx populations in the GYA (Unit 5) and in the Garnet Mountains of Unit 3 may indicate the lower level of resiliency expected among small and relatively more isolated populations. The persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population; however, the post-fires increase in home range size and likely decrease in lynx numbers may indicate the population is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Overall, the apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historic conditions suggest adequate historical and recent levels of resiliency of lynx populations in the DPS.

In summary, the lynx DPS currently exhibits adequate redundancy to preclude extirpation as a result of catastrophic events. The genetic health and ecological diversity expressed across the DPS range likewise suggest a currently adequate level of representation. The long-term persistence and apparent broad geographical distribution of lynx populations in four of the six geographic units also suggests the current adequacy of resiliency in the DPS, although the potential recent extirpation of several small populations may be an indication of inadequate resiliency in those places.

4.1.1 Summaries of Current Conditions in Each Geographic Unit

Unit 1 - Northern Maine: This geographic unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) in northern Maine, but small areas of similar habitat also occur in northern New Hampshire and northern Vermont. Resident lynx in this unit are part of a larger population that also occupies southern Quebec and northern New Brunswick, Canada. At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that the largest reproducing resident population of lynx in the DPS likely occurs in this unit (numbers and trends unknown, but enough habitat exists to support possibly 500 to 1000 lynx). Small numbers of reproducing lynx have also been documented recently in northern New Hampshire and northern Vermont. Historically, lynx distribution in this unit was patchy, and lynx populations were likely low and dependent on immigration from Canada. Forest management is now the primary driver of hare and lynx habitat in this DPS unit. Current lynx and hare habitat is historically high because of young, regenerating softwood forests created by extensive clearcutting and herbiciding to salvage spruce-fir following a severe spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Lynx responded to these conditions with high survival and reproduction, small home ranges, and moderate population densities. State forestry regulations passed in 1989 caused landowners to shift to various forms of partial harvesting that have resulted in lower landscape hare densities across much of the unit. Hares do not seem to cycle in this region, but underwent a 50 percent decline starting in 2006 and have remained at lower levels. Reproduction and survival rates in the low-hare environment suggest a slightly declining population. Unlike other units of the DPS, lynx habitat in northern Maine occurs nearly entirely on private, industrial forest lands, and landowners do not have long-term commitments to lynx management. The majority of lands in Maine are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with hare and lynx habitat. Other potential stressors on private lands include large-scale wind energy development, residential and resort development, and parcelization of forestlands from rapid turnover in investment company landowners. The next spruce budworm outbreak is imminent, but forestry response by investment landowners is uncertain. Climate change is a concern as snow depth and duration are currently at the minimum thresholds believed necessary to give lynx a competitive advantage over bobcats and other mesocarnivores. There is currently no clear evidence of climate change effects on lynx distribution.

Unit 2 - Northeastern Minnesota: This geographic unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps, and black spruce or tamarack bogs. Despite uncertainty when the DPS was listed, it has become apparent that a reproducing resident population of roughly 50 to 200 lynx exists in northeastern Minnesota. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario, where trapping of lynx is legal. Lynx in Minnesota select regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites are associated with regenerating and mixed forest (Burdett 2008, p. 57). Hare densities in parts of northeastern Minnesota appear to be sufficient to support a viable lynx population; and densities

are highest in regenerating forests (McCann and Moen 2011, p. 513). The Superior National Forest continues to manage in accordance with its 2004 Forest Plan, and several risk factors are being minimized and managed to promote the conservation of lynx within the SNF. Management of lynx habitat on state and private lands is voluntary. Factors affecting current conditions in this unit primarily include forestry management, roads, incidental trapping, mining development, snow compaction, competition with bobcats, and lynx-bobcat hybridization. Forty-nine lynx mortalities due to vehicle and train collisions as well as incidental trapping and shooting have been reported in Minnesota since the species was listed.

Unit 3 - Northwestern Montana/Northeastern Idaho: There are no reliable estimates of current or historic resident lynx numbers in this geographic unit, but it is thought to be capable of supporting 200-300 lynx home ranges. Habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Minor genetic differences suggest three subpopulations in the northwest (Purcell Mountains), central (Seeley Lake), and southern (Garnet Mountains) parts of the unit. No lynx have been detected in the Garnets after 2010, but whether this indicates the extirpation of a small (7-10 individuals) previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit, including federal, State, Tribal, and some private lands, is managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire supporession) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx, with the Garnets being a possible exception. Wildfire extent has increased over the past several decades, likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Hare densities have not been estimated broadly throughout the unit but appear to be low or marginal even in most of what is considered the highest-quality habitat, suggesting that even small decreases in habitat quality/hare densities could influence its continued ability to support resident lynx. The role of past and recent immigration in maintaining the demographic and genetic health of current lynx populations in this unit is unknown, but peaks in cyclic lynx numbers in Canada have declined, especially when compared to the unprecedented irruptions of the early 1960s and 1970s, and there is no evidence of significant immigration into this unit since then.

Unit 4 - North-central Washington: This geographic unit encompasses approximately 5,176 km^2 (1,988 mi^2), 91.5 percent federally owned. It contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia, directly north of this unit, and maintaining connectivity with Canada is considered important to maintaining lynx populations in this unit. There are no reliable estimates of current or historic resident lynx numbers in this unit, but recent habitat and home range analyses (summarized in Lewis 2016) suggest that it may have been capable of supporting 65-90 lynx prior to recent large wildfires. Those fires affected about 50 percent of the potential lynx

habitat, led to increased home range size, and may have reduced the current carrying capacity of this unit to 40-55 lynx. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943). There is significant risk for potential future wildfires to further affect the viability of lynx in this geographic unit. Burned habitats are expected to regenerate back into suitable lynx habitat, but this may take 35-40 years. The Kettle Range to the east of this unit was suspected to have supported a small (likely fewer than 20 individuals) resident population until about 30 years ago when over-trapping may have resulted in its extirpation (Koehler *et al.* 2008, p.1523). Potential impediments to lynx movement between the Kettle Range and the Cascades and British Columbia may make natural recolonization of the Kettle Range unlikely. Results of snowshoe hare research suggest that the hare population density in Washington exists at the low end of the range thought necessary to support lynx reproduction (>= 0.5 hares/ha). The OWNF and CNF, which administer more than 90 percent of lynx habitat in Washington, continue to manage lynx habitat on their forests in accordance with the LCAS. Additionally, the WADNR, which manages approximately 4 percent of lynx habitat in Washington, has developed and is implementing its 2006 Lynx Plan, which is also largely based on the LCAS.

Unit 5 - Greater Yellowstone Area (GYA): There are no reliable estimates of current or historic lynx numbers in this unit but, given its naturally-fragmented potential habitat, generally low hare densities, and the paucity of verified records, it appears unlikely this unit ever supported a large resident population. No lynx have been verified in this unit after 2010, but whether this indicates the extirpation of a small but previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most of this unit consists of federal lands (97.5 %) that are currently managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx. Wildfire extent has increased over the past several decades, predominantly in the northern half of the unit and likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Snow conditions currently appear to be adequate, with most of this geographic unit modeled to have a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12). Hare densities were very low in most of Yellowstone National Park but high in parts of the Bridger-Teton National Forest in the southern half of the unit. The role of past and recent immigration in maintaining the demographic and genetic health of lynx populations in this unit is unknown. This unit lacks direct connectivity to other lynx populations, and there is only anecdotal evidence that irruptions of lynx from Canada resulted historically in immigration into this unit. Some lynx released in Colorado dispersed northward into this unit and temporarily occupied home ranges in areas used previously by native resident lynx, but there is no evidence of reproduction among these lynx.

Unit 6 - Western Colorado: Lynx habitat in Colorado is distributed west of US Interstate-25. This unit is not directly connected to lynx populations in Canada. Compared to the time of listing and completion of the Southern Rockies Lynx Amendment, two bark beetle epidemics have altered

large areas of lynx habitat in Colorado. Similarly, large wildfires have reset successional conditions in many areas. Areas affected by beetles that contained multistoried stand conditions likely continue to provide habitat to support snowshoe hares and lynx. Areas affected by beetles and fire require 20 plus years to recover to a point where the stands will again support snowshoe hares. The CPW completed their lynx reintroduction, and based on information generated during on-going studies, and reports received by CPW and the USFS, lynx continue to persist, at least in the San Juan Mountains. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell undocumented pers comm. April 4, 2016), and Rocky Mountain National Park (Shenk 2008, page 3). Habitat that supports snowshoe hares is patchily distributed in this geographic unit, which limits their abundance. Because the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. The majority of lynx habitat in Colorado continues to be managed by the USFS, providing conservation through the Southern Rockies Lynx Amendment. However, regulatory mechanisms for the conservation of lynx are lacking on approximately 3,611 km^2 (1,394 mi^2) [14 percent] of some BLM, NPS, and other non-federal lynx habitat.

Table 3. Summary of current conditions in six geographic units within the DPS range.

	Unit 1 - Northern ME	Unit 2 - Northeastern MN	Unit 3 - Northwestern MT, Northeastern ID	Unit 4 - North-central WA	Unit 5 - Greater Yellowstone Area	Unit 6 - Western CO
Unit Size (km^2)	26,909	21,101	29,997	5,176	23,687	25,294
Percent of Unit in Conservation Ownership (i.e., Federal, State, Tribal, Other Conservation Org.)	<10	75 - 90	> 95	> 90	> 95	> 90
Connectivity to Lynx Populations/ Habitats in Canada	Directly connected to lynx habitats/ populations in s. Quebec and n. New Brunswick; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Ontario; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Alberta and s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown
Home Range Size (Adult Female, km^2)	26	17 - 21	43 - 115	37 - 91	50 (1 female, 3 years)	75 - 704
Productivity – Percent Females with Kittens	89% (high hares); 30% (low hares);	100%	83% (Purcells); 61% (Seeley Lake)	100% (2 females)	Few data	24%
Productivity - Litter Size	2.74 (high hares); 2.25 (low hares)	3.3	2.95 (Purcells); 2.24 (Seeley Lake)	2.25 (2 females)	3.0 (1 female, 2 years)	2.75
Average Annual Adult Survival Rate	0.80 (high hares); 0.71 (low hares)	0.75 - 1.00	0.85 (Purcells); 0.75 (Seeley Lake)	0.86	Few data	0.93 (in Core Release Area [CRA]), 0.82 (out of CRA)
Lambda (Annual Rate of Population Change)	1.16 (high hares, 6 yrs); 0.88 (low hares, 4 yrs)	No estimate	1.16 (Purcells, 4 yrs); 0.92 (Seeley Lake, 8 yrs)	No estimate	No estimate	No estimate

4.2 Current Conditions - Detailed Descriptions by Geographic Unit

4.2.1 Unit 1 - Northern Maine

The “Northern Maine unit” includes the core, occupied habitat in northern Maine, which is designated critical habitat. It also includes areas where lynx have recently occurred in western and eastern Maine and northern New Hampshire and Vermont. To be consistent with the Workshop Report, we refer to this collective region as the Northern Maine unit.

Unit Description: This unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) primarily in northern Maine, but also small areas of northern New Hampshire and Vermont. Climate in this region is characterized by warm summers and some of the coldest temperatures and highest snowfalls in the eastern U. S.; a function of latitude, elevation, and distance from the ocean. The average terrain rises in northern Maine to 1,000-1,500 feet with mountain peaks, particularly in western Maine, northern New Hampshire and Vermont from 3,000 to 5,000 feet. This region is far enough inland to be unaffected by marine influences. Annual precipitation is 41 inches (104 cm), with greatest precipitation in winter in the form of snow 228 cm to 280 cm (90 to 110-plus inches), with higher amounts at higher elevations. Snow duration is about four months (mid-November through mid-April).

Maine - Much of the lynx habitat in northern Maine occurs within the designated critical habitat boundary, which is approximately 28,909 square kilometers (11,162 square miles) all in northern Maine (79 FR pp. 54823-54828). Land ownership in the critical habitat unit boundary is about 92 percent private, 7 percent State (primarily Baxter State Park), 1 percent tribal (Passamaquoddy Tribe, Penobscot Indian Nation), and contains no federal land. Private lands are almost entirely commercial forest lands. Lynx regularly occur outside of the designated critical habitat boundary in parts of eastern and western Maine and, recently, in northernmost New Hampshire and Vermont (see below).

New Hampshire - Habitat in northern New Hampshire is not within the designated critical habitat. Potential habitat is limited (Hoving 2001, p. 59), and the few habitat patches that support lynx in New Hampshire are much smaller than those in northern Maine (Litvaitis and Tash 2005, Fig. 2 and p. A–298; Robinson 2006, Fig. 3.3, p. 99). Hoving (68 FR 40086) estimated approximately 1,000 square kilometers (386 square miles) of potential habitat having a greater than 50 percent probability of being occupied by lynx. Litvaitis and Tash (2005, p. A–298) estimated that New Hampshire contains about 342 km2 (888 km2) of potential Canada lynx habitat. Historic distribution in New Hampshire included Coos and northern Carroll and Grafton counties (i.e. White Mountain National Forest; Siegler 1971, Silver 1974, Hoving *et al.* 2003). Habitats with the highest probability of occurrence are in Pittsburg in northern New Hampshire and the White Mountain National Forest in the central area of the state (Siren 2014, p. 34). The majority of the habitat in northern New Hampshire is located on the Connecticut Lakes Natural Area WMA which is owned and managed by NHFG. Surrounding habitat is owned and managed by the Connecticut Lakes Timber Company under a conservation easement held by the State of NH. Occurrence records from the past 10 years have been

centered on these two ownerships (Kilborn 2015, App. A pp. 42-43). Habitat on the Connecticut Lakes Natural Area has a conservation easement with 15,000 acres of the core lynx habitat also being part of an unmanaged area of the 25,000 acre property. As a result these core 15,000 acres will be allowed to mature to a climax forest type potentially allowing for good denning habitat but restricting the amount of snowshoe hare habitat in the foreseeable future. Current conditions are in a transition state, and portions of the 15,000 acres are supporting higher densities of snowshoe hare because of past forest management (Kilborn 2015, App. A pp. 42-43). Regional-scale modeling suggests that a high component of deciduous forest and insufficient snow conditions in New Hampshire are unlikely to support viable lynx populations over time (Hoving *et al.* 2005, pp. 739, 749).

Vermont - Habitat in northern Vermont is not within the designated critical habitat. Recent modeling to determine lynx habitat connectivity in the Northeast suggests that the Nulhegan River Basin contains Vermont's best lynx habitat (Farrell 2012). The 530 square kilometer (205 square mile) area is approximately 20 percent federal (Nulhegan National Wildlife Refuge), 17 percent State (Vermont Department of Natural Resources), and 63 percent private commercial timber lands (with easement). The future of lynx and their habitat is unlikely because of the patchy and limited amount of habitat, climate change (decreasing snow), trends toward hardwood management, and increasing human disturbance (Vermont Fish and Wildlife 2015, Appendix A5 p. 127).

The Northern Maine geographic unit is directly connected to lynx habitats and populations in southern Quebec and northern New Brunswick, Canada. Lynx in this unit represent the southern extent of a larger cross-border population, most of which occurs in the Gaspe region of southern Quebec and northern New Brunswick (Ray *et al.* 2002, pp. 17-20). Lynx in the northern Maine unit are geographically isolated by the St. Lawrence River from lynx populations in central Quebec (120 km north of Maine). Lynx populations in Maine and eastern Canada are geographically isolated from other lynx populations on the island of Newfoundland (900 km east of Maine), and on Cape Breton Island, Nova Scotia (650 km southeast of Maine) (Koen *et al.* 2015, entire). The closest lynx population in the DPS is located in northeastern Minnesota, about 1,700 km west of Maine.

Habitat Description: In the northern Maine unit, most lynx occurrence records are found within the broadly described ''Mixed Forest-Coniferous Forest-Tundra'' cover type (68 FR, p. 40086). This habitat type occurs along the northern Appalachian Mountain range from southeastern Quebec, western New Brunswick, and western Maine, south through northern New Hampshire. This habitat type becomes naturally fragmented and begins to diminish to the south and west, with a disjunct segment running north-south through Vermont, and a patch of habitat in the Adirondacks of northern New York (McKelvey *et al.* 2000b, pp. 248-250). This area is part of the Acadian Forest Region (Rowe 1972, p. 112-129) representing a transition between northern boreal spruce and balsam fir and southern temperate deciduous forests (Seymour and Hunter 1992, pp. 3-4). Northern Maine is characterized by low-relief, hilly terrain, but with some higher elevations up to 1,600 meters (Katahdin highlands, western Maine, White Mountains in central New Hampshire). Higher elevations support a predominantly coniferous forest (white, red, and

black spruce; balsam fir; eastern white pine) intermixed with northern hardwoods (red maple, aspen, white birch, sugar maple, beech, and yellow birch). Lowland areas include spruce-fir flats interspersed with peatlands (black spruce, tamarack).

Current lynx and hare habitat are associated with spruce-fir stands repeatedly harvested for forest products. Hares and lynx are associated with stands of regenerating sapling (15–35 years old) spruce-fir forest that provide dense cover (Robinson 2006, pp. 26–36; Vashon *et al.* 2012, p. 15). Lynx are more likely to occur in large (100 square kilometer, 40 square mile) landscapes having a high percentage (>27 percent) of regenerating forest, and less likely to occur in landscapes with very recent clearcut or partial harvest (Hoving *et al.* 2004, pp. 291–292, Simons-Legaard *et al.* 2013, entire). Regenerating stands used by lynx generally develop after forest disturbance (almost exclusively logging) and are characterized by dense horizontal structure and high stem density within a meter of the ground. These habitats support the highest snowshoe hare densities (Homyack 2003, p. 63; Fuller and Harrison 2005, pp. 716, 719; Vashon *et al.* 2005a, pp. 10–11). At the stand scale, lynx in northwestern Maine selected older (11- to 26-year-old), tall (15 to 24 feet (ft) (4.6 to 7.3 meters (m)) regenerating clearcut stands and older (11- to 21-year-old) partially harvested stands (Fuller *et al.* 2007, pp. 1980, 1983–1985). At the home range scale, lynx also select landscapes having some mature conifer forest (Simons-Legaard *et al.* 2013, pp. 572–573). Lynx may select partial harvested and mature conifer stands because of increased ease of travel and prey access along the extensive edges with high-quality (regenerating clear-cut) habitats (Simons-Legaard *et al.* 2013, p. 574).

Most of the high-quality hare and lynx habitat in northern Maine is the result of extensive landscape-scale clearcut timber harvesting in response to a spruce budworm outbreak in the 1970s–1980s (Simons 2009, pp. 64, 218). Some of these clearcuts were also treated with herbicides to promote conifer regeneration by suppressing deciduous tree species. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). Historically, the natural disturbance regime (fires, windthrow, insect outbreaks) resulted in smaller, more frequent disturbances and long intervals between larger disturbances.

Snowshoe hare populations in Maine do not seem to cycle at 10-year intervals, but have experienced a period of high (1995-2005) and low (2006 to present) populations (Scott 2009, pp. 1-44, D. Harrison, UMaine, unpub. data, Vashon *et al.* 2012, p. 14). Prior to 2006, several estimates of hare densities in the highest quality, regenerating conifer or mixed forest averaged 1.9 (Homyack *et al.* 2007, p. 8) to 2.1 hares/ha (Robinson 2006, p. 26,). After 2006, hare densities declined by about half in all stand types and have remained at these lower levels (Scott 2009, p. 109, D. Harrison, UMaine, unpub. data). Similar trends were observed in the Gaspe Region of Quebec (Assells *et al.* 2007, entire). In 1990, hare densities in dense, regenerating spruce-fir stands in New Hampshire were 0.5 hares/ha at low and high elevation (Brocke *et al.* 1990, p. 61). More recently, Siren *et al.* (2015) reported lower densities in New Hampshire (0.25 to 0.36 hares/ha) in both montane and lowland spruce-fir. Densities in high elevation (krumholtz, stunted spruce-fir) were only 0.19 to 0.28 hares/ha. Comparable hare

density data are not available for Vermont or New York. The average landscape hare density in home range-sized areas occupied by lynx in Maine was 0.74 hares/ha (Simons-Legaard *et al.* 2013, p. 567). Based on these observations, Simons-Legaard *et al.* (2013, p. 576) recommended maintaining landscape hare densities of at least 0.74 hares/ha (or 27 percent of 100 km2 areas in high-quality hare habitat) to conserve lynx.

Habitat Status: As elsewhere in the DPS, boreal spruce-fir forest habitats in the northern Maine unit are patchily distributed and intermixed with northern hardwoods, riparian areas, and peatlands. USFS forest inventory data indicate that four million acres of forestland are classified as spruce-fir in Aroostook, Penobscot, Piscataquis, and Somerset Counties in northern Maine (McWilliams *et al.* 2005, p. 122), although not all of this forest type is in areas occupied by lynx. In a 10 million acre area in northern Maine (approximately 50 percent of the designated critical habitat), Simons-Legaard (2016, p. 9-10) estimated that approximately 950,000 acres (9.5 percent) of spruce-fir was in a young, regenerating stand condition that provide high quality hare habitat. This habitat is similar to, and contiguous with, forested areas in Quebec and New Brunswick, Canada that support lynx (Hoving *et al.* 2005, pp. 740-741). The current range of lynx in the northern Maine unit is associated with areas of deep snowfall, extensive (100 km2 [40 mi2]) forested landscapes, and areas having a high proportion of regenerating conifer-dominated forest that had previously been treated with herbicides to suppress hardwoods (Homyack 2003, p. 2; Hoving *et al.* 2004, p. 287).

Lynx habitat in the northern Maine unit is associated with large-scale, intensive forest management (Harper *et al.* 1990, entire; Hoving *et al.* 2004, pp. 291-292; Simons 2009, p. 8; FR 74 8616–8701). Patches of boreal forest in New Hampshire, Vermont, and New York are more highly fragmented and smaller than in northern Maine. These more southerly forests also contain a higher proportion of northern hardwood. These forests are believed to lack the conifer component needed to produce sufficient snowshoe hare densities to consistently support viable populations of lynx (Hoving *et al.* 2005, p. 749, Carroll 2007, p. 1100).

During winter, lynx primarily selected tall (4.4–7.3 m [14.5–24 ft]) regenerating clearcuts and partially harvested stands that were 11–21 years post-harvest (Fuller *et al.* 2007, pp. 1984-1985). Lynx avoided mature stands (>40 years old) and short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partially harvested stands <10 years post-harvest (Fuller *et al.* 2007, pp. 1275-1278). Further research of year-round habitat use yielded similar results, with lynx preferentially using conifer-dominated sapling stands that were 3.4–7.3 m (11–24 ft) in height and supported high densities of snowshoe hares (Vashon *et al.* 2008b, pp. 1492-1495). Lynx tended to forage in areas with intermediate to high snowshoe hare densities (tall regenerating or older partial harvest stands), which afforded lynx with greater mobility and where snowshoe hares were more vulnerable to predation, rather than in the densest stands (short regenerating stands; Fuller and Harrison 2010, pp. 1276-1278).

Denning habitat included various types of coarse woody debris; blowdown, deadfalls, and root wads. In northern Maine, the majority of natal dens (12 of 26) occurred in conifer-dominated

sapling stands, and 6 dens were found in mature or mixed multi-story forest stands dominated by conifers (Organ *et al.* 2008, pp. 1515-1517).

In general, landscape scale and home range scale habitat selection by lynx on industrial forest lands reinforce the importance of dense regenerating conifer forest along with a component of mature conifers (Hoving *et al.* 2004, p. 286; Vashon *et al.* 2008a, pp. 1494-1495, Simons 2009, pp.64-110; Simons-Legaard *et al.* 2013, p. 568). Simons-Legaard *et al.* (2013, p. 573) found the probability of lynx occurrence was >50 percent when snowshoe hare landscape densities were >0.74 hares/ha (0.39/ac) and there was >10 percent mature conifer forest. In Maine, lynx selected softwood-dominated (spruce and fir) regenerating stands (Fuller *et al.* 2007, pp. 1983-1985; Vashon *et al.* 2008a, pp. 1492-1495) and adjacent older (11–21 years post-harvest) partially-harvested stands (Fuller *et al.* 2007, pp. 1983-1985). Lynx were more likely to occur in landscapes with abundant regenerating forest, and less likely to occur in landscapes dominated by recent clearcut or partially harvested stands (Hoving *et al.* 2004, pp.289-292). Regenerating stands used by lynx typically developed 15–30 years after harvest (Hoving *et al.* 2004, p. 291), and were characterized by high stem density and dense horizontal cover within 1 m (3 ft) of the ground (Robinson 2006 pp. 33-35, Scott 2009, pp. 81-93; Fuller and Harrison 2010, p. 1276-1278). These habitats supported high snowshoe hare densities (Homyack 2003, p. 53; Fuller and Harrison 2005, p. 716, Vashon *et al.* 2008a, p. 1492; Scott 2009, pp. 24, 32, 36-44). At a landscape scale, lynx habitat selection did not differ between sexes; however, at a home range scale, males tended to use more mature forest dominated by conifers than females, and both male and female lynx tended to avoid mature forests that had a high deciduous component (Vashon *et al.* 2008a, pp. 1492-1493).

Historically lynx habitat in the northern Maine unit was likely uncommon. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). In the Northeast prior to European settlement, lynx habitat was created and maintained by frequent, small-scale forest gap dynamic events and infrequent, large-scale stand-replacing forest disturbances (Seymour *et al.* 2002, pp. 359-365; Lorimer and White 2003, pp. 54-58). Higher elevation boreal forests are often characterized by an even-aged wind-throw phenomenon known as fir-waves (Sprugel 1976, entire). Large, stand-replacing events (fire, wind and ice storms, insect outbreaks) are rare (interval of several hundred to several thousand years) and highly variable in size (Seymour *et al.* 2002, entire; Lorimer and White 2003, pp. 50, 54, 59). Spruce budworm, spruce beetle, beech bark disease, and sugar maple defoliators have been important influences affecting forest landscape patterns (McNab and Avers 1994, Chapter 14). The frequency and intensity of spruce budworm outbreaks, the most likely insect to affect lynx habitat, have been highly variable in Maine and eastern Canada in recent centuries (Blais 1983, entire). In this geographic area, wildfire is less significant as a natural agent of disturbance. The typical fire regime is infrequent surface fires in the dormant season in the hardwood forests, and slightly more frequent but long-interval fires in conifer forests (Kilgore and Heinselman 1990, entire; Seymour *et al.* 2002, pp. 359-365, Lorimer and White 2003, p. 59). For the past several decades, early successional forests and lynx habitat in northern Maine, New Brunswick, and

southern Quebec have been created almost exclusively by forest management (Lorimer and White 2003, pp. 42-43).

In contrast, current habitat is likely peaking and at historical highs. Favorable habitat conditions for snowshoe hare and lynx in Maine resulted from large-scale salvage cutting (clearcutting) following a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, p. 291). After salvage harvest of the affected trees, a portion of the area was sprayed with herbicide to reduce deciduous competition (Scott 2009, pp. 7, 14). The resulting vegetation was dominated by balsam fir and red or black spruce (Scott 2009, p. 60). This created favorable habitat conditions for snowshoe hares and lynx. Habitat conditions for hares and lynx in the unit improved from the late-1980s to present, benefitting from stand-replacing salvage harvests during the last budworm outbreak (Simons 2009, pp. 122-229; Simons-Legaard *et al.* 2016, entire). During this time period, the percentage of forestland with an average landscape hare density greater than 0.5 hares/ha increased 400 percent (Simons-Legaard *et al.* 2016, p. 7).

Lynx habitat will decline in the near future. In response the widespread clearcutting in the 1980s, in 1989 Maine passed the Forest Practices Act. This Act regulated clearcutting. Various forms of partial harvesting replaced clearcutting as the predominant form of forest management in northern Maine. Partially harvested stands (e.g., selection harvest, shelterwood harvest, overstory removal) have a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006, p. 29). On average, partially harvested stands support about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006, p. 26-27).

Maine's forest practices shifted dramatically after the Maine Forest Practices Act. Over 95 percent of cutting that occurs now in northern Maine is partial harvesting compared to 59 percent in 1988 (Scott 2009, p. 8; Simons 2009, pp.45-47, 69-71; Simons-Legaard *et al.* 2013). This new cutting regime supports lower landscape densities of snowshoe hares (Fuller 1999, Homyack 2003, Robinson 2006, Scott 2009).

Long-term, binding land management commitments are lacking in the northern Maine unit. Unlike federal lands, there is no requirement that private landowners comply with lynx management guidelines, and a federal nexus for review of projects is almost nonexistent. Furthermore, there continues to be high turnover in forest land ownership (Hagan *et al.* 2005, Nadeau-Drillen and Ippoliti 2006) and little funding to provide incentives or to work with private landowners. As of 2005, there were 23 landowners in northern Maine with land holdings in excess of 100,000 acres including the State, federal government (White Mountain National Forest south of lynx range), a conservation group (The Nature Conservancy), two tribes (Penobscot Indian Nation and Passamaquoddy Tribe with much land south of lynx range) and 18 private forest landowners (Nadeau-Drillen and Ippoliti 2006, p. 13).

There are short-term commitments to manage lynx habitat in the northern Maine unit. In 2003, Congress passed the Healthy Forest Restoration Act. Title V of this Act designates a Healthy Forest Reserve Program (HFRP) with objectives to: (1) promote the recovery of threatened and

endangered species, (2) improve biodiversity, and (3) enhance carbon sequestration. In 2006, Congress provided the first funding for the HFRP, and Maine, Arkansas, and Mississippi were chosen as pilot States to receive funding through their respective Natural Resources Conservation Service (NRCS) State offices. Based on a successful pilot program, in 2008, the HFRP was reauthorized as part of the Farm Bill, and in 2010, NRCS published a final rule in the Federal Register (75 FR 6539) amending regulations for the HFRP based on provisions amended by the bill.

In 2006 and 2007, the NRCS offered the HFRP to landowners in the proposed Canada lynx critical habitat unit in Maine to promote development of Canada lynx forest management plans. Since that time four private landowners, The Nature Conservancy, the Passamaquoddy Tribe, Merriweather LLC, and Katahdin Forestlands successfully enrolled in the program. Collectively, these land ownerships comprised 943.2 mi2 (2,443 km2), or 9.3 percent of the total designated critical habitat in northern Maine.

The NRCS required that lynx forest management plans must be based on the Service's ''Canada Lynx Habitat Management Guidelines for Maine'' (McCollough 2007, entire). These guidelines were developed from the best available science on lynx management for Maine. The guidelines required maintenance of landscapes having hare densities that support reproducing lynx populations. Notably, HFRP forest management plans provided a net conservation benefit for lynx, which was achieved by employing the lynx guidelines, identifying baseline habitat conditions, and meeting NRCS standards for forest plans. Plans met NRCS HFRP criteria and guidelines and complied with numerous environmental standards. Plans were reviewed and approved by the NRCS with assistance from the Service. The details of the plans are proprietary and will not be made public per NRCS policy.

Short-term commitments to lynx management will expire in 2016 and 2017. Unlike lynx forest plans on federal lands, HFRP plans lack long term commitments beyond an initial 10-year contract period. Plans were prepared for a forest rotation (70 years) and include a decade-by-decade assessment of the location and anticipated condition of lynx habitat on the ownership. However, landowners are only committed to a 10-year contract, and long-term commitments to lynx management are voluntary. Some landowners developed plans exclusively for lynx, and others combined lynx management (umbrella species for young forest) with American marten (umbrella species for mature forest) and other biodiversity objectives. All four plans have been completed and contracts with NRCS will expire in 2016 and 2017. Landowners have the option to convert HFRP contracts into Safe Harbor Agreements or other agreements to provide regulatory assurances, however, at this time this option has not been explored with landowners.

Many large private forest landowners in the northern Maine unit have commitments to endangered species management through forest certification programs. For example, The Nature Conservancy land enrolled in the HFRP is also enrolled in the Forest Stewardship Council (FSC) forest certification program, which requires safeguards for threatened and endangered species. Other landowners are certified under the Sustainable Forestry Initiative (SFI). Both certification programs require planning for threatened and endangered species.

However, certification programs are also voluntary and may not be long-term commitments. Given the frequent turnover in Maine forest lands, new landowners do not always renew certification or resume the certification programs initiated by the previous landowner.

Lynx Status: At the time of listing, lynx were known to be present in northern Maine but little was known about their distribution, population size, and trend, snowshoe hare populations, and relationships to forest management. Since then, research from the Maine Department of Inland Fisheries and Wildlife (Vashon *et al.* 2008a, entire; 2008b, entire; and 2012 entire) and the University of Maine (Hoving *et al.* 2003, entire; Hoving *et al.* 2004, entire; Hoving *et al.* 2005, entire; Homyack *et al.* 2005, entire; Homyack *et al.* 2007, entire; Homyack *et al.* 2006, entire; Fuller *et al.* 2007, entire; Fuller *et al.* 2004, entire; Fuller and Harrison 2005, entire; Simons-Legaard *et al.* 2013, entire; Simons-Legaard *et al.* 2016, entire) have greatly increased our knowledge. Snow track surveys and confirmed occurrence records (Vashon *et al.* 2012, entire; Siren 2015, entire) document that lynx occur throughout northern Maine and in small, isolated pockets in western and eastern Maine, northern New Hampshire, and Vermont (Siren 2015, entire). Population size and trends are still uncertain.

The Northern Maine Unit currently supports a breeding population of lynx that encompasses most of northern Maine, with recent lynx occurrence and reproduction also documented in northernmost New Hampshire and Vermont. This geographic unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspe region of southern Quebec. Extensive areas of contiguous forestland in this region provide high connectivity between populations in Maine and Canada. Although potential lynx habitat in New Hampshire and Vermont is fragmented, there is near contiguous forest and connectivity for lynx movement between these areas and habitats in northern Maine (Farrell 2013 personal communication, FR 54821). Breeding lynx in New Hampshire and Vermont are not directly connected to Canadian populations, but they are connected to the larger population in northern Maine via habitat in western Maine.

Lynx in the Northern Maine Unit and adjacent populations in southern Quebec and northern New Brunswick are separated from lynx populations in the interior of Canada. The St. Lawrence River restricts lynx dispersal and demographically isolates this population from those in northern Quebec, Labrador, and Ontario. However, sufficient numbers of individuals cross the river on the ice each generation to prevent genetic drift of this population (Koen *et al.* 2015).

At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that a significant population currently exists and is supported by the extensive young, regenerating spruce-fir habitat created by clearcutting in the 1970s and 1980s. Habitat in northern Maine can support lynx densities in localized areas of high quality habitat that are substantially greater than elsewhere in the DPS (LCAS 2013, p. 23). In 2003 when hare populations were high, lynx density (juveniles and adults) in one of Maine's highest quality habitats was estimated to be 9.2-13.0 lynx/100km^2 (Vashon *et al.* 2008, Vashon *et al.* 2012, p. 15). At about the same time, the density of lynx in nearby Gaspe Peninsula, Quebec was estimated to be 10 lynx/100km^2 (Ray *et al.* 2002). These densities are intermediate to those

in Canada during the high (17.0-44.9/100km^2) and low periods (2.3 – 3.0/100km^2) of the lynx-hare cycle (Poole 1994, Slough and Mowat 1996, O'Donaghue *et al.* 1997). Simons (2009, p. 102) estimated there is potential for a population of about 236 to 355 adult lynx to occur on a 3.56 million acre study area (about half of the critical habitat area) in northern Maine, and Vashon *et al.* (2012, appendix IV) estimated there is potential for a population of 750 to 1,000 adult lynx in all of northern Maine in 2006. The actual number of lynx is unknown because there are no methods available to measure and produce true population estimates over such a large geographic area.

Lynx populations in New Hampshire and Vermont may consist of only a few animals, although breeding has occurred in both locations in recent years. Most historic lynx records from New Hampshire are from trapping records from the 1930s to the 1960s (Brocke *et al.* 1993, McKelvey *et al.* 2000). There were only two records in the 1990s. In 2003, the Service determined that, despite a lack of breeding records, a small resident population likely occurred historically in New Hampshire but no longer exists (68 FR 40087). Lynx were detected in northern New Hampshire in 2006 and have occurred there annually since (Siren 2014 pp. 53, 55). In 2011, 4 lynx kittens were observed in Pittsburg and were considered evidence of breeding in New Hampshire (Kilborn 2015 Appendix A p.44). There were only four historic records of lynx in Vermont prior to 2003. Since then, nine lynx sightings have been confirmed. Reproduction was first documented in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Vermont Fish and Wildlife 2015, Appendix A5 p. 126).

Lynx do not presently occur in the Adirondacks region of New York. A resident lynx population reportedly occurred in the northern region of New York, particularly in the Adirondack Mountains, but it was considered extirpated by 1900 (Brocke 1982, McKelvey *et al.* 2000b). However, there are 23 verified lynx occurrences since 1900, primarily from the Adirondack Mountains (McKelvey *et al.* 2000b). The most recent verified record was from 1973 (McKelvey *et al.* 2000b), which correlates to an extreme cyclic population high. Habitat and prey conditions were deemed suitable for a lynx reintroduction in 1989–1991 (Brocke 1982). The reintroduction was unsuccessful in establishing a population. In 2003 the Service concluded that a resident population may have existed in New York prior to 1900, however, records of lynx since 1900 are of dispersers (68 FR 40087).

Maine lynx had spatial and demographic parameters similar to some northern populations during the cyclic high in the snowshoe hare cycle (Brand *et al.* 1976, Parker *et al.* 1983, O'Donaghue *et al.* 1997). Maine lynx had among the smallest home ranges in the DPS (LCAS 2013, p. 24). During the period when snowshoe hare populations were highest, Maine lynx had among the highest reproductive rates (average litter size 2.74, 89 percent of adult females producing litters) in the DPS (Vashon *et al.* 2012, pp. 18-19). During the current period of low hare density, litter size was smaller, only 30 percent of females have litters, and mortality is greater. Home ranges are among the smallest in the DPS (54 + 5 km2 males; 26 + 4 km2 females, LCAS p. 24, Vashon *et al.* 2008a). Home range sizes were similar during periods of high and low hare density (Mallett 2014). Lynx populations likely increased during the period of

high hare density (lambda [λ] = 1.16) and declined during periods of low hare density (λ = 0.88) (USFWS, Vortex10, deterministic population simulation 2016; demographic data from Vashon *et al.* 2012).

In summary, Maine lynx and hare habitats are at historical highs. In the Northeast prior to European settlement, lynx habitat was created and maintained by small-scale, frequent forest gap dynamic events and large-scale, infrequent (stand-replacing) forest disturbances (Seymour *et al.* 2002, Lorimer and White 2003). Historically, lynx distribution was patchy, and lynx populations were likely low and dependent on immigration from Canada. Current habitat is the result of widespread clearcutting and herbiciding to salvage spruce and fir damaged by a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008). Maine lynx at multiple scales select extensive areas of regenerating, dense (7,000 – 14,000 stems/ha) spruce-fir stands 15 to 35 years after clearcut or other even-aged harvest (Hoving *et al.* 2005, Fuller *et al.* 2007, Vashon *et al.* 2008, Simons-Legaard *et al.* 2013). Lynx habitat is expected to remain stable for the next few years then decline (Simons-Legaard *et al.* 2016).

Factors Affecting Current Conditions: *Climate Change* - Climate change is affecting temperature, snow, and precipitation patterns in the Northeast at rates faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46^{o} C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Climate change has, and will continue to affect lynx by reducing snow and boreal forest (see section 5.1.1).

Snow Duration, Depth, and Quality - As noted in chapter 2, lynx occur where there is regularly at least four months (120 days) of continuous snow coverage (Gonzales *et al.* 2007). Snow cover days in northern New England (1965-2005) ranged from 60-121 days and declined an average of 3.6 days/decade from 1965-2005 (Burakowski *et al.* 2008). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Thus, average conditions in Maine are currently at or below the snow persistence thresholds believed to be needed to support lynx (Gonzales *et al.* 2007). Similarly, the largest snow depth decreases in Canada in the last six decades have been observed in the lower St. Lawrence Valley, immediately north of Maine (Brown and Braaten 1998, pp. 48-52).

Lynx in the Northeast and eastern Canada occur where there is regularly total snowfall of at least 270 cm/yr (106 in/yr; Hoving *et al.* 2005), which defines the distribution of lynx and bobcat in this region (Hoving *et al.* 2005, Carroll 2007, Peers *et al.* 2013). Average annual snow depth at 5 weather stations within the range of the lynx in northern Maine (1981-2010) was below this threshold, 228-263 cm (NOAA 2011, http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html, last accessed 31 March, 2016). In the last 50 years, 18 of 23 snow sampling sites in and near Maine experienced reduce depth of snowpack (Hodgkins and Dudley 2006). Snow depth in New England (1965-2005)

declined an average of 4.6 cm/decade (Burakowski *et al.* 2008). Thus, average snow conditions in Maine are currently at or below this snow depth threshold, and further declines in annual snow depth would be expected to give bobcats a competitive advantage over lynx (Hoving *et al.* 2005,)

As noted in chapter 2, lynx and snowshoe hare require deep, fluffy snow that provides lynx with a competitive advantage over bobcats and gives hares the ability to reach winter browse. Snow quality ("fluffiness") has deteriorated in the Northeast. Unlike other units, annual precipitation in Maine is increasing because of climate change, but primarily as rain (A. Siren *in* Lynx SSA Team 2016, p. 15; Fernandez *et al.* 2016), and especially rain on snow events in winter in northern Maine (Huntington and Hodgkins 2004, Deser *et al.* 2013, Fernandez *et al.* 2015). Snow density and compaction and crust conditions (caused by wet, heavy snow or rain on snow events in winter) have increased in northern New England (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006) and southern Canada (Karl *et al.* 1993).

Vegetation Management - The effects of forest management on foraging and denning habitat for lynx in northern Maine are discussed in the Habitat Description and Habitat Status sections above.

Wildland Fire Management - Although fire is frequent in many boreal forest regions, it is not a stressor for lynx in northern Maine. Annual precipitation is comparatively greater in this unit than others, and conditions for fire are infrequent. The fire regime in this unit is infrequent (50- to 200-year interval) and generally small (several acres) surface fires in the dormant season. Large (up to 80,000 acres) stand-replacing fires are rare and occur at a less frequent interval (800- to 9000-years) (Seymour *et al.* 2002 p. 360). In contrast, spruce budworm outbreaks cause stand-replacement over large areas every 100–250 years (Cogbill, 1985).

Habitat Fragmentation - Habitat fragmentation (smaller and more isolated patches of high quality hare habitat) caused by current forest practices in northern Maine is discussed in the Habitat Description and Habitat Status sections above.

Other Factors: *Trapping* - This unit is directly connected to lynx habitats and populations in southern Quebec, where trapping of lynx is legal. Several lynx that were captured and radio-tagged in northern Maine were subsequently trapped in southern Quebec (Vashon *et al.* 2012).The lynx trapping season was closed in the Northern Maine Unit (including New Hampshire and Vermont) for decades prior to lynx being listed as a threatened species. Carroll (2007) modeled lynx populations in this unit and demonstrated that increased trapping pressure in Quebec could have a negative effect on protected lynx populations in Maine and New Brunswick. About 400 lynx are trapped and killed annually in Quebec south of the St. Lawrence River (http://mffp.gouv.qc.ca/english/wildlife/statistics/index.jsp last accessed May 19, 2016). In 2014, the Maine Department of Inland Fisheries and Wildlife (MDIFW) obtained an incidental take permit from FWS for lynx trapped incidental to other furbearer trapping in Maine. From 2000 to 2015, 108 lynx have been reported captured in traps set for other species and 7 of

those were killed (Vashon *et al.* 2012, MDIFW 2014, p. 75). No lynx have been reported incidentally trapped in New Hampshire or Vermont since 2000. In Maine, after two lynx were killed in killer-type traps in 2014, MDIFW imposed additional trapping restrictions (e.g., requiring killer-type traps be placed in exclusion boxes, eliminating the use of drag sets for foothold traps) to further reduce mortality and injury of incidentally-trapped lynx.

Trapping of Canada lynx can be additive to other sources of mortality and have population-level effects (Brand and Keith 1979, Koehler and Aubrey 1994). Thus, harvest regulations for lynx are modified when hare and lynx populations are low (Bailey *et al.* 1986). Trapping mortality is not likely to have a great effect on lynx populations in northern Maine and adjacent Canada when lynx are at historically high numbers, but trapping could have a synergistic and negative effect if hare and lynx populations decline, habitat declines, or climate change further stresses lynx (Slough and Mowatt 1996, Carroll 2007).

Wind Power Development - In response to climate change, wind development has escalated in northern and western Maine posing a potential threat to high and low elevation spruce-fir habitats (Whitman *et al.* 2013). Climate conditions are at or falling below threshold values needed to support lynx in Maine (see section above). Maine has experienced a rapid increase in wind energy development (http://www.eia.gov/electricity/data/browser, last accessed August 2, 2016), and there is increased interest in placing developments on private lands in unpopulated areas throughout northern Maine, New Hampshire, and Vermont. Wind energy is an increasingly appealing source of income for investment companies and other landowners who own forestland in the northern Maine unit. As of 2016, at least 11 wind projects have been proposed in northern Maine and 5 projects are in operation; 2 have been proposed in northern New Hampshire and 2 are in operation; and 3 have been proposed for northeast Vermont and 2 are in operation or under construction. Maine's two largest wind projects (combined over 200 turbines covering 360 mi2) are proposed entirely within Maine's lynx critical habitat. The effects of wind energy projects on lynx, hares and their habitat are undocumented. Potential direct effects include disturbance or displacement of resident lynx and loss and fragmentation of habitat from turbines, roads, and transmission lines. Increasing power infrastructure associated with these projects could greatly change development potential and patterns in northern Maine by bringing electricity into the interior of Maine's vast, undeveloped forest region. Extensive road construction further fragments habitat and increases access for recreation, including trapping.

Changing Land Ownership and Development - Until recently, the northern Maine unit was largely undeveloped, industrial forestland, but land ownership patterns have changed significantly in the last 15 years (Nadeau-Drillen and Ippoliti 2006). Some investment-oriented landowners are seeking diversified financial returns on their investment, including developing residential housing, second homes, and resorts. Two large residential and resort areas have been proposed on forestlands within the Maine critical habitat area. Both development projects would result in the development of several thousand acres of potential lynx habitat, but would be mitigated by substantial (100,000s of acres) conservation easements on surrounding forestland. Another private landowner proposes donation of a 87,000 acres within the lynx critical habitat for a federally-designated national park or monument. This area currently has a legacy of

young-regenerating spruce-fir habitat from previous industrial forest landowners, but a park or monument designation would forego future forest management. Another conservation landowner, The Nature Conservancy, continues forest management on about half of its 185,000 acre ownership, including managing part of the area for Canada lynx.

Construction or expansion of developed areas such as residential areas and resorts, as well as smaller recreational sites like nordic ski huts or campgrounds, may directly remove forest cover. Such removal in lynx habitat could decrease prey availability, affect lynx movement within home ranges, or result in a more fragmented landscape. Development further fragments habitat from road and highway construction (along with associated increases in traffic volumes and/or speeds).

Northern Maine Unit Summary - In summary, lynx are currently widespread throughout northern Maine and in small patches of habitat in northern New Hampshire and Vermont. Habitat exists to support a potential population of 500 to 1000 lynx, although the actual population size is unknown. Habitat created by extensive clearcutting 30 to 40 years ago is peaking and will decline by 50 percent in the next 15 to 20 years (Simons-Legaard 2016, p. X; also see section 5.1.1, below). Furthermore, hare populations declined by 50 percent starting in about 2006 and have remained at lower levels. Future hare fluctuations or cycles are uncertain. Active management of forest lands can produce lynx habitat, but landowners do not have long-term commitments for doing so. Land ownership has dramatically changed in northern Maine, and the majority of lands are owned now by investment companies who wish to diversify income from their investments which could result in forest practices inconsistent with lynx habitat. Greatest stressors are habitat loss (shifts in forest management from clearcutting to partial harvesting resulting in lower landscape hare densities), lack of forest planning for lynx, and climate change (diminishing snow depth, quality and duration; competition from bobcats and fishers; loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing ice conditions on the St. Lawrence River).

4.2.2 Unit 2 - Northeastern Minnesota

Unit Description: This unit encompasses approximately 21,100 square kilometers (8,147 square miles) in northeastern Minnesota. It includes the area designated as critical habitat in 2014 (79 FR 54782) and an additional relatively small area of tribal land in northern Minnesota that was excluded from critical habitat. Land ownership in this unit is about 47 percent federal (primarily USFS, with some NPS and BLM land); 36 percent State; 16 percent private; and 1 percent Tribal (Grand Portage Reservation) (see Table 1). This unit includes most of Superior National Forest (SNF; including the Boundary Waters Canoe Area Wilderness [BWCAW]) and Voyageurs National Park. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario (ON). Relative to other DPS lynx populations, this unit is about 1,480 km (920 mi) east of the Northwest Montana/Northeast Idaho Unit and about 1,610 km (1,000 mi) west of the Northeastern Maine geographic unit.

Habitat Description: In Minnesota, most lynx occurrences are associated with the Mixed Deciduous/Conifer Forest (McKelvey *et al.* 2000b, pp. 246, 248) within the Laurentian Mixed Forest Province (McNab *et al.* 2005, p. 5). Most of this province is characterized by low-relief hilly landscapes with glacial features and an elevation from sea level to 2,400 feet (730 meters), including many lakes and rivers. This unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps and black spruce or tamarack bogs. Coniferous and mixed-coniferous/deciduous vegetation types are dominated by balsam fir; black and white spruce; northern white cedar; Jack, white and red pine; hemlock; and tamarack; mixed with aspen and paper birch (Burdett 2008, p.5; Moen *et al.* 2009, pp.1-2; McCann and Moen 2011, p. 510). Burdett (2008, p. 57) reported that lynx in Minnesota selected regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites were associated with regenerating and mixed forest. McCann and Moen (2011, p. 513) found snowshoe hare densities were highest in regenerating forests. Females selected large woody debris and dense horizontal cover in lowland conifer cover for denning in northern Minnesota (Moen *et al.* 2008, p. 1510), but other cover types were used if recent blowdowns were present (Moen and Burdett 2009, p. 5).

Hare density in parts of northeastern Minnesota appears to be sufficient to support a viable lynx population (Moen *et al.* 2008, p. 1512), ranging between 0.3–2.0 hares/ha (0.12–0.8 hares/ac; McCann 2006, p. 17). Hare populations in northeastern Minnesota appear to be patchily distributed, but are most consistently abundant in 10-30 year old regenerating forests (McCann 2006, p.45). Pellet count data prior to the 1990s show evidence of density fluctuations of snowshoe hare populations occupying Minnesota (Fuller and Heisey 1986, pp. 262-263), but these fluctuations were not observed during the 1990s (Hodges 2000b, p. 172). Snowshoe hare habitat in Minnesota primarily consists of conifer forests with dense low-growing understories, lowland shrub and conifer bogs. Conifer bogs or lowland conifer forests may be especially important during low points in hare cycles by acting as refugia for hares. Early regenerating or pole-sized stands are not used as much as in other portions of their range, although older regeneration stands were used frequently in Minnesota (McCann 2006, p. 45). Sapling-sized aspen adjacent to conifer cover may also provide functional snowshoe hare habitat. McCann and Moen (2011, pp. 512-513) mapped the distribution of predicted snowshoe hare habitat across northeastern Minnesota. In northeastern Minnesota, edge habitats and regenerating conifer stands appeared to be important for snowshoe hare populations (Burdett 2008, p. 58; McCann 2006, p. 45), as were dense habitats containing balsam fir, white spruce, and cedar (Fuller and Heisey 1986, p. 263). Recent research indicates that the red squirrel is not an important prey species for lynx in northeastern Minnesota (Burdett 2008, p. 62; Hanson & Moen 2008, p. 9).

Average annual snowfall in this unit ranges from about 180 cm (71 in) in the northwestern part of the unit near International Falls, Minnesota to 219 cm (86 in) in Duluth, Minnesota, on the southern end of the unit, to 228 cm (90 in) in Tofte, Minnesota, near the lake shore on the far eastern-central part of the unit, to 228 cm (90 in) in Isabella, Minnesota, near the center of the unit, to the 107 cm (42 in) in Grand Portage, Minnesota, at the northeastern tip of the unit. More

snow is produced along Lake Superior, because of the lake effect (https://snowfall.weatherdb.com/d/a/Minnesota; accessed 4/25/2016).

Habitat Status: Friedman and Reich (2005, p. 732) conducted a spatially explicit forest composition change analysis on a 3.2 million hectare study area in northeastern Minnesota, which was based on General Land Office Survey records from the late 1800s and the 1990 USFS Inventory and Analysis Survey. The study documents altered forest tree species abundance, proportional basal area, and spatial distribution patterns. The proportionally most abundant species in northeastern Minnesota shifted from the presettlement period (spruce, 21 percent; larch, 15 percent; and paper birch, 15 percent) to aspen (30 percent), spruce (16 percent), and balsam fir (16 percent) in 1990. White pine declined from 20 percent to 5 percent basal area dominance, birch from 16 percent to 13 percent, spruce from 14 percent to 9 percent, and larch from 12 percent to 2 percent, while aspen increased from 8 percent to 35 percent basal area dominance.

In 2015, the SNF estimated that there were approximately 759,700 acres (60 percent of lynx habitat on the SNF) of suitable snowshoe hare habitat on the SNF and that only 23,800 acres of habitat on the SNF was in a condition unsuitable to lynx (USDA 2016, unpublished data).

The SNF continues to manage in accordance with its 2004 Forest Land and Resource Management Plan (USDA 2004, entire). The Forest Plan emphasizes providing sustainable amounts of timber, maintaining or enhancing biodiversity, contributing to economic and social needs of the community, and managing in an environmentally sound manner to produce goods and services that provide for long-term public benefits (USDA 2004, entire). The Forest Plan includes many objectives, standards, and guidelines for the protection of lynx and enhancement of lynx habitat that are based on recommendations in the 2000 LCAS. LAUs were delineated on the SNF in 2000 as the smallest landscape scale on which to analyze effects to lynx. The boundaries have remained in place since that time to allow for long term analysis of project effects. However, the SNF Plan proposed several changes of current LAU boundaries, such as adding LAUs to the Virginia Management Unit of the Laurentian Ranger District; designating the BWCAW a lynx refugium.

This unit is directly connected to lynx habitats and populations in southern Ontario, where trapping of lynx is legal. Habitat connectivity within and between portions of northeastern Minnesota and Canada appears functional based on radio-telemetry data that have documented lynx movements between Minnesota and Ontario (Burdett *et al.* 2007, p. 458; Moen 2009, pp. 4-6; Moen *et al.* 2010b, p. 5).

Lynx Status: At the time of listing, the Minnesota population was not believed to contribute significantly to the DPS. However, we now know that a reproducing resident population exists in northeastern Minnesota. Moen (*in* Lynx SSA Team 2016) recently estimated the potential for a population of about 50 to 200 lynx to occur in northeastern Minnesota. In 2008, Moen *et al.* (2008b), estimated the number of lynx that might be resident in northeastern Minnesota at a given time as between 190 and 250 individuals, assuming that about 25 percent of northeast

Minnesota is suitable lynx habitat, coupled with assumptions about residence time and detectability. The actual number of lynx is unknown because methods have not been implemented to measure and produce precise population estimates over such a large geographic area. We have no estimates of lynx densities in Minnesota.

Home range sizes in Minnesota were reported as 194 km^2 (75 mi^2) males and 87 km^2 (34 mi^2) females (Mech 1980, p.263). Later radio-collar data show that males had much larger home ranges 267 km^2 (103 mi^2) than females 21 km^2 (8 mi^2); and that females with kittens had the smallest home range (Burdett *et al.* 2007, pp. 460-461). A study of radio-collared lynx in Minnesota documented approximately 40 percent of male and female lynx making long distance movements outside of their home range between Ontario, Canada and Minnesota (Moen *et al.* 2010b, p. 17). Of those lynx that made long-distance movements, females tended to move 62-124 miles (100-200 km) and did not return to their original home range, while males moved 31-49 miles (50-80km) back and forth between Ontario and Minnesota (Moen *et al.* 2010b, p. 17). While topographic features may influence lynx movements in mountainous western states, lynx in Minnesota tended to move nearly straight paths (Moen *et al.* 2010b, p. 13).

The SNF and others have identified 268 unique individual lynx (48 percent Female, 51 percent Male) from DNA samples taken since 2000 (Catton *et al.* 2015, p. 1). Of the 1,306 DNA samples, 1,039 were identified as lynx, however 42 samples were identified as F1 lynx-bobcat hybrids (Catton *et al.* 2015, p. 1). Of those 42 hybrids, 13 unique individual lynx-bobcat genotypes (5 Female, 8 Male) were also identified (Catton *et al.* 2015, p. 1). The DNA analyses also showed persistence of individual lynx in Minnesota of 2 years (N = 27 lynx), 3 years (N = 11), 4 years (N = 5), 5 years (N = 6), and 1 female lynx tracked for over 5 years, who produced 7 kittens in Minnesota (Catton *et al.* 2015, pp. 3-5).

Since 2000 the U.S. Fish and Wildlife Service has been tracking incidental take of lynx; 29 lynx mortalities have been reported from trapping, shooting, vehicle collisions, and railroad mortalities in Minnesota. Thus far, of 26 lynx documented to have been incidentally trapped in Minnesota, 11 died and 15 were released alive (U.S. Fish and Wildlife Service, unpublished database 2016). The documented incidents largely occurred during legal trapping that targeted bobcat, coyote, fox, and marten, and involved a variety of traps including foot-holds, body gripping traps, and snares (U.S. Fish and Wildlife Service, unpublished database 2016). In addition, seven lynx mortalities as a result of being incidentally shot have been documented in Minnesota and 16 died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Lynx emigrating from Minnesota to Ontario exposes them to trapping and shooting that is allowed in accordance with regulated harvest in Canada. At least a third of the animals radio-collared in Minnesota spent time in Ontario; 4 radio-collared lynx were legally harvested (trapped) in Canada between 2003 and 2010, and two died of unknown causes (U.S. Fish and Wildlife Service, unpublished database 2016). Furthermore, nine lynx mortalities due to vehicle collisions have been documented in Minnesota since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). Minnesota has relatively high forest road and highway densities that intersect lynx habitat and several radio-collared lynx in Minnesota inhabited home ranges that were bisected by highways. In addition to road mortalities, two railroad mortalities

have been documented since 2000 (U.S. Fish and Wildlife Service, unpublished database 2016). It is probable that there are additional incidental catches that are not reported each year (Moen 2009).

Factors Affecting Current Conditions: Identified factors affecting to the current conditions of lynx in Minnesota include reduction in habitat quality or quantity, habitat fragmentation, climate change, increased access for competing carnivores, and human-caused mortality. The SNF is currently implementing the 2004 SNF Plan (USDA 2004, entire), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the SNF has a long-term commitment for doing so; however, private landowners do not. Under the Sustainable Forest Resource Act of 1995, the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx. The implementation of the MFRC guidelines is monitored annually (e.g., MDNR 2015, entire). Thus, the several risk factors are being minimized and managed to promote the conservation of lynx within the SNF, however implementation of the guidelines on privately owned lands is voluntary.

Activities that change forest structure can affect habitat quantity and quality for lynx and snowshoe hares, their primary prey source. Thinning and other timber management practices that reduce stem density and downed material and promote more open, mature stands can reduce habitat quality and quantity. Throughout the Superior National Forest and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Mineral exploration and development is increasing in portions of Minnesota, particularly for hard rock (non-ferrous) minerals. Some of the area of interest for minerals overlaps with lynx habitat in northeastern Minnesota. Mineral exploration may result in short-term displacement of lynx. Mining activities and associated development may result in an irreversible loss of habitat or increased mortality risk. The specific effects to lynx and their habitat will depend on the scale and type of each project.

Roads are a factor in human-caused lynx mortality where they provide access to areas where lynx occur, increasing the risk of negative interactions between people and lynx. Throughout the SNF outside the BWCAW, high and low standard roads bisect many areas that provide potential or suitable lynx habitat. Additionally, bobcat harvest in northeastern Minnesota has been increasing over the last decade (Erb 2012, unpaginated). Where lynx and bobcat overlap, there is potential for accidental shooting of lynx, or for bobcat hunting with dogs to harass or harm lynx.

Snow compacts under natural conditions; however, snow compacted by human activity may increase access by coyotes and bobcats to prey in deep snow conditions where historically they were excluded or rare. Winter road use, snowmobiling, cross country skiing, and dog sledding

all have the effect of compacting snow. Outside the BWCAW, snowmobile activity is extensive and increasing significantly. The SNF has 705 miles of snowmobile trails and 1,562 miles on all ownerships within the proclamation boundary (USDA 2011). Advances in snowmobile capabilities have raised concerns about intrusion and new snow compaction in areas previously not vulnerable to high levels of snowmobile use. In addition, new road construction in lynx habitat has made more areas accessible during winter. These routes could be used by snowmobiles even if new roads are designated as closed to motorized public travel during other seasons. The SNF has 1,927 miles of low standard roads (OML 1 and 2) and 158 miles of temporary roads (USDA 2011). All of these factors have potential to reduce the deep and fluffy winter snow conditions and to reduce the competitive advantage of lynx in areas that typically receive deep snows.

As described in Chapter 2, above, lynx are adapted for surviving in areas that have cold winters with deep, fluffy snow, where they outcompete potential competitors such as bobcats, coyotes, and wolves (Buskirk *et al.* 2000a, pp. 90-91; McCord & Cardoza. 1982, pp. 748-749; Ruediger *et al.* 2000). The geographical distribution of bobcat harvest in Minnesota has remained relatively static with a lack of harvest in the Arrowhead region of Minnesota (the region encompassed by Cook, Lake and St. Louis counties in northeastern Minnesota) (Erb 2009 cited in Kapfer 2012, p. 16, Erb 2012, pp. 7-9) and annual snow track and scent stations surveys support the conclusion that bobcats are as rare in the Arrowhead as harvest indicates (MN DNR unpublished data cited in Kapfer 2012, p. 23). However, this may change with decreased snow conditions predicted to occur due to climate change (Kapfer 2012, p. 25). Bobcat and coyote populations already appear to be increasing in Minnesota (Erb 2014, p. 40). If snow depth and duration decrease in the Arrowhead, deer mortality may be reduced which may potentially increase bobcat densities and bobcat expansion into northeast Minnesota (Kapfer 2012, p. 25). According to annual track surveys, wolf populations in Minnesota are currently stable (Erb 2014, p. 40), however, similar to bobcat, wolf populations may increase with changing snow conditions and prey availability as influenced by climate change.

Furthermore, in Northeastern Minnesota, several lynx-bobcat hybrids have been documented (Catton *et al.* 2015, p. 1), however, most bobcat records occur south and west of the core part of the lynx range in Minnesota (see figure 1.1 *in* Kapfer 2012, p. 51). Bobcat populations are increasing in Minnesota (Erb 2014, p. 40) and more bobcat-lynx hybridization may occur as a result of climate change (Koen *et al.* 2014, p. 113).

4.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Unit Description: This geographic unit includes the parts of northwestern Montana and northeastern Idaho the Service designated as critical habitat (Unit 3) for lynx in 2014 and some Tribal and State lands that were excluded from that designation (79 FR 54825). It encompasses approximately 27,000 km^2 (10,424 mi^2) in portions of Boundary County in Idaho and Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton Counties in Montana, with ownership that is 84 percent federal (USFS,NPS, and BLM); 8 percent private; 4 percent State; and 4 percent Tribal. Most federal lands in this unit (82 percent) are on national

forests managed by the USFS; with NPS (16 percent) and BLM (almost 2 percent) contributing most of the remainder. This unit includes most of Glacier National Park and parts of the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests, the BLM's Garnet Resource Area, and the Confederated Salish and Kootenai Tribes Flathead Reservation. It also includes (from northwest to southeast) all or parts of the Purcell, Cabinet, Salish, Whitefish, Lewis, Flathead, Swan, and Garnet mountain ranges. Several areas adjacent to this unit are known or thought to support a small number of resident lynx, at least intermittently, including the southern Selkirk Mountains of northern Idaho and northeastern Washington and the western Cabinet Mountains of northern Idaho (B. Holt 2016, pers. comm.; USFS 2015, pp. 9-10), and a small area of the Helena National Forest just south of MacDonald Pass, between Helena and Missoula (Gehman *et al.* 2011, p. 21). This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit may represent the southern extent of a larger cross-border population that also occurs in southwestern Alberta and southeastern British Columbia (B.C.). Relative to other DPS lynx populations, this unit is about 200 km (125 mi) east of the north-central Washington unit, about 145 km (90 mi) northwest of the GYA, and about 1,480 km (920 mi) west of the Northeastern Minnesota geographic unit.

Habitat Description: In the Northern Rocky Mountains, most lynx occurrences are associated with the Rocky Mountain Conifer Forest or Western Spruce-Fir Forest vegetative classes (Kuchler 1964, p. 4; McKelvey *et al.* 2000a, p. 246) at elevations ranging from 1,250 m (4,100 ft) to 2,500 m (8,200 ft) (Aubry *et al.* 2000, pp. 378–380; McKelvey *et al.* 2000a, pp. 243–245). The dominant vegetation that constitutes lynx habitat in these areas is subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanii*) and lodgepole pine (*Pinus contorta*) (Aubry *et al.* 2000, p. 379; Ruediger *et al.* 2000, pp. 4-8 - 4-10). Within these vegetation types, lynx appear to prefer areas of moderate to gentle topographic relief (Koehler and Aubry 1994, p. 86; Apps 2000, p. 352; Squires *et al.* 2013, pp. 187, 191). Lynx use large landscapes that include a temporally- and spatially-shifting mosaic of forest age classes, where natural or anthropogenic disturbances may reset forest succession (ILBT 2013, p. 28). Early successional stages that often provide dense horizontal cover at ground/snow level and support high hare densities (Griffin 2004, pp. 53-54, 70; Squires *et al.* 2010, pp. 1654-1656) may be created and maintained by natural disturbance processes including wildfire, insect infestations, tree diseases, and wind events (ILBT 2013, p. 28). Timber harvest, other silvicultural treatments, wildfire management, or other vegetation management, which may be beneficial, benign, or adverse to lynx and hare habitats depending on prescription, extent, and implementation, can also influence the amount and distribution of early successional stands (Agee 2000, p. 39; ILBT 2013, pp. 28, 71-76). Likewise, natural disturbance regimes and forest management can also influence the amount and distribution of mature multistoried spruce-fir stands, which can include dense horizontal structure, support high hare densities (Griffin 2004, pp. 53-54, 70; Squires and Ruggiero 2007, pp. 313-314; Berg *et al.* 2012, pp. 1483-1485), and provide preferred winter foraging habitat for lynx (Squires *et al.* 2010, pp. 1653-1657).

In northwestern Montana, lynx generally occur in mid-elevation (1,260 – 2,355 m [4,130 – 7,730 ft]) moist subalpine mixed-conifer forests dominated by Englemann spruce and subalpine fir and including Douglas fir (*Pseudotsuga menziesii*), western larch (Larix occidentalis), and lodgepole

pine (Squires *et al.* 2010, pp. 1653-1654). Lynx home ranges occur in areas with low surface roughness (i.e., low topographic relief; gently-sloping to moderately-steep terrain), high canopy cover indices, and little open grassland (Squires *et al.* 2013, p. 191). These lynx habitats occur below the alpine zone and above drier, more open forest types (e.g., ponderosa pine [*Pinus ponderosa*] and dry Douglas-fir/western larch/lodgepole pine) that do not provide lynx habitat (Agee 2000, p. 42; Berg 2009, p. 20; Squires *et al.* 2010, p. 1655). As elsewhere in the western portion of the DPS, this elevational pattern contributes, along with the transition from boreal to more temperate forests, to a naturally patchier, more fragmented distribution of lynx habitat than in the continuous boreal forest landscape in the core of the lynx's North American range in northern Canada and interior Alaska (65 FR 16052-53; 68 FR 40089; Squires *et al.* 2006[a], pp. 46-47; ILBT 2013, pp. 76-77; Squires *et al.* 2013, p. 191; 78 FR 59438). Squires *et al.* (2013, pp. 187-189) used telemetry data to model the distribution of probable lynx habitat in a 36,096-km^2 (13,937-mi^2) study area that completely overlaps this geographic unit. Their results indicate that much of the area has a low to moderate probability of selection by lynx, and that the areas with higher selection probabilities are relatively small and patchily- but widely- distributed throughout the unit and are separated by intervening areas of low probability of lynx use (Squires *et al.* 2013; see Figure 1(a), p. 189). This patchy distribution of high-quality habitats interspersed with areas of low-quality or non-habitat results in naturally lower densities of both snowshoe hares and lynx than those in the continuous boreal forests of northern Canada and Alaska (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373–375, 382, 394).

In winter in this unit, lynx preferentially use mature multistoried forest stands, predominantly spruce-fir, with dense horizontal cover, and they avoid clearcuts and large forest openings (Squires *et al.* 2010, pp. 1648, 1653–1656). In summer, lynx also select young stands with dense spruce-fir saplings, do not appear to avoid openings as in winter, and use slightly higher elevations (Ibid.). Both mature multistoried and young regenerating stands provide dense horizontal structure at ground/snow level, which supports higher snowshoe hare densities than more open young or mature forests. In the central (Seeley Lake study area) part of this unit, during an apparent regional hare decline in 1999-2001, summer hare densities were highest (up to 1.4 hares/ha in one study area) in dense young stands and winter densities were highest (up to 1.8 hares/ha in one study area) in dense mature stands (Griffin and Mills 2009, pp. 1492-1496). Over a longer interval (1999-2003) when hare populations in this area were thought to be stable (Squires and Ruggiero 2007, p. 314), mean summer and winter hare densities, respectively, were 0.34 hares/hectare (ha) and 0.53/ha in dense mature stands and 0.64/ha and 0.47/ha in dense young stands – habitats selected by lynx, compared to 0.18/ha and 0.20/ha in open mature stands and 0.18/ha and 0.12/ha in open young stands that lynx did not select (Squires and Ruggiero 2007, pp. 313-314). Even the relatively higher hare densities in the dense mature and dense young stands only marginally achieve the threshold density of 0.5/ha thought necessary to support lynx within home ranges (Ruggiero *et al.* 2000b, pp. 446–447; ILBT 2013, pp. 24, 26, 90). Nonetheless, hares accounted for 96 percent of the biomass in lynx diets in this unit based on evidence at kill sites (Squires and Ruggiero 2007, pp. 310-313), suggesting that even small declines in landscape-level hare densities could reduce the ability of habitats in this unit to support resident lynx (Squires *et al.* 2010, p. 1656).

Lynx in this unit generally den in mature spruce-fir forests among downed logs or root wads of wind-thrown trees in areas with abundant coarse woody debris and dense understories with high horizontal cover in the immediate areas around dens (Squires *et al.* 2004a, Table 3; Squires *et al.* 2008, pp. 1497, 1501–1505). Few dens are located in young regenerating or thinned stands with discontinuous canopies (Squires *et al.* 2008, p. 1497). Many dens have northeasterly aspects and are farther from forest edges than random expectation (Squires *et al.* 2008, p. 1497).

Average annual snowfall in this unit ranges from about 142 cm (56 in) in the Kalispell/ Whitefish/ West Glacier area of northwestern Montana to 183 cm (72 in) in Nordman in northern Idaho, to 216 cm (85 in) in Lincoln, Montana, near the southern end of the unit, to 259 cm (102 in) in Rexford, Montana near the Canada - U.S. border, to 345 cm (136 in) in Seeley Lake, Montana, in the central part of the unit, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 4/2/2016).

Habitat Status: Lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 84 percent (22,761 km^2 [8,788 mi^2]) of this unit is in federal ownership, including 18,695 km^2 (7,218 mi^2) in national forests under USFS management, 3,658 km^2 (1,412 mi^2) in Glacier National Park managed by NPS, and 397 km^2 (153 mi^2) managed by BLM in its Garnet Resource Area. As described above, potential lynx habitat in this unit is patchily- distributed and interspersed with areas of non-habitat (matrix). Among the six national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 54 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123). In Glacier National Park, 2,976 km^2 (1,149 mi^2; about 73 percent of the park) is considered “lynx forest types” (65 FR 16073), but only 1,103 km^2 (426 mi^2; 27 percent of the park, 37 percent of lynx forest types) is estimated to be lynx habitat (68 FR 40086, 40089). In the Garnet Resource Area, the BLM designated five LAUs (which approximate a lynx home range) covering 947 km^2 (366 mi^2), of which, 574 km^2 (222 mi^2; about 61 percent) was mapped as lynx habitat (Sparks 2016a, pers. comm.).

Federal lands are managed as either ‘‘developmental’’ or ‘‘nondevelopmental’’ land use allocations (68 FR 40093). Lands in developmental allocations are managed for multiple uses, such as recreation and timber harvest, some of which may conflict with lynx conservation. Management within non-developmental allocations focuses on the maintenance of natural ecological processes, or conservation of rare ecological settings or components, and these areas include wilderness, roadless, and semi-primitive non-motorized areas (USFWS 2007, pp. 33, 77). Timber harvest, road construction, and fire suppression typically do not occur or are very limited in lands managed in non-developmental allocations.

In this SSA unit, almost 46 percent of the federal land and 40 percent of the entire unit is in designated wilderness or national park land, including (in addition to Glacier National Park) the 6,297-km^2 (2,431-mi^2) Bob Marshall Wilderness Complex (Bob Marshall, Great Bear, and Scapegoat wilderness areas) on the Flathead, Lewis and Clark, Helena and Lolo national

forests, the 302-km^2 (117-mi^2) Mission Mountain Wilderness on the Flathead National Forest, the 139-km^2 (54-mi^2) Rattlesnake Wilderness Area on the Lolo National Forest, and the 371-km^2 (143-mi^2) Mission Mountain Tribal Wilderness on the Flathead Reservation. Management of NPS lands and both national forest and Tribal wilderness areas provides restrictions on land use beneficial to lynx (65 FR 16073; USFWS 2014, pp. 28-29; 79 FR 54831), and adverse effects of management activities on lynx habitats in these areas are unlikely. Among the six national forests that contribute to this unit, 56 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34).

Much of the remaining USFS lands and the BLM lands have developmental land-use allocations where some management activities have the potential to impact lynx or its habitat. However, as described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2004 amended the Resource Management Plan (RMP) for the Garnet Resource Area to incorporate the conservation measures identified in the LCAS (BLM 2004a, 2004b, entire; Sparks 2016b, pers. comm.). Both documents provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently- applied framework for conserving and restoring important hare and lynx habitats.

Habitat status on private lands, which account for about 8 percent of lands in this unit (2,172 km^2 [839 mi^2]), is governed by some federal and State regulations and buy a number of private-public conservations partnerships and State agency efforts. As described in section 3.1., above, some federal and State regulations guide some activities on private lands, including the ESA's prohibition on take of listed species, and State regulations governing trapping and timber management. In addition to these protections, there have been several other notable lynx conservation achievements on private lands in this unit since the DPS was listed. Two of these, the Clearwater-Blackfoot Project and the Montana Legacy Project, are multi-partner and community efforts led by The Nature Conservancy in Montana to purchase large tracts of private commercial timberlands, conveying some to the State of Montana and the USFS for conservation management, and acquiring conservation easements on others (TNC 2016a, 2016b, 2016c, entire). These land acquisitions have resulted in protection of roughly 673 km^2 (260 mi^2) of important lynx habitat within this SSA unit and another 583 km^2 (225 mi^2) just to the south and west that may occasionally or temporarily support lynx or provide dispersal habitat. Additionally, the MTFWP has acquired fee title or conservation agreements on 3,096 km^2 (1,195 mi^2) of private lands in western Montana, including 162 km^2 (63 mi^2) in designated lynx critical habitat in this SSA unit, with ongoing efforts on another 106 km^2 (41 mi^2) in the northwest part of the unit (MTFWP 2016, pp. 1, 3).

In addition to the MTFWP's efforts to acquire private lands and protect them through fee title or conservation agreement, the State of Montana has also worked to protect lynx habitat on State-owned lands, which account for about 4 percent of the lands in this unit (1,106 km^2 [427 mi^2]). As described above in section 3.1.2, the MTDNRC worked closely with the Service to develop the *State of Montana Department of Natural Resources and Conservation Forested State Trust Lands Habitat Conservation Plan* (MTDNRC HCP; MTDNRC and USFWS 2010a, 2010b, 2010c, entire); a multi-species HCP that focuses primarily on commercial forest management. The HCP includes a Lynx Conservation Strategy that minimizes impacts of forest management activities on lynx, describes conservation commitments that are based on recent information from lynx research in Montana, and commits to active lynx monitoring and adaptive management programs. The HCP covers about 2,220 km^2 (857 mi^2) of forested State trust lands in western Montana, including 703 km^2 (271 mi^2) within this SSA geographic unit (about 64 percent of State lands in this unit). The goal of the HCP's Lynx Conservation Strategy is to support federal lynx conservation efforts by managing for habitat elements important to lynx and their prey that contribute to the landscape-scale occurrence of lynx. Specific objectives to achieve this goal include protecting den sites and potential denning habitat, mapping and maintaining lynx foraging habitats and limiting the spatial and temporal scope of their conversion to unsuitable conditions from forest management activities, and providing for habitat connectivity (MTDNRC and USFWS 2010b, pp. 2-45 - 2-61). The HCP was finalized and permitted by the Service in 2011, and includes a 50-year commitment by the State to manage for lynx conservation on these lands (79 FR 54835-37).

Tribal lands of the Flathead Reservation account for almost 4 percent of this unit. In addition to the Tribe's approach to lynx management described in section 3.2.1, above, most lynx and lynx habitat on the reservation occur in areas with formal protective status, including: (1) The long-designated Mission Mountains and Rattlesnake Tribal Wilderness Areas, which are largely roadless and managed for wilderness qualities; (2) the South Fork/Jocko Primitive Area, which is open to use only by Tribe members and in which commercial timber harvest is prohibited; and (3) the Nine-mile Divide country, which is marginal in terms of lynx habitat, but which is also partly roadless (Courville 2014, pers. comm.; 79 FR 54831).

As elsewhere in the DPS, winter foraging habitat is thought to be the most limiting habitat for lynx in this unit (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27). As described above, lynx selected mature multistoried stands with dense horizontal structure and relatively higher winter hare densities (Squires *et al.* 2010, pp. 1648, 1653–1656). Because of this preference, the Forest Service in the NRLMD adopted a vegetation management standard (VEG S6) that precludes all vegetation management activities that could reduce winter snowshoe hare habitat in multistoried forests, not just precommercial thinning as recommended in the LCAS (USFS 2007, pp. 13-14). Also as elsewhere (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517, ILBT 2013, p. 30; 79 FR 54790), denning habitat is not thought to be a limiting factor for lynx in this unit (Squires *et al.* 2008, p. 1505). Nonetheless, the NRLMD includes guidance to ensure adequate denning habitat remains well distributed in LAUs and, therefore, across the larger landscape and to design projects to create or retain coarse woody debris in areas where denning habitat may be lacking (USFS 2007, p. 17). Snow conditions in this unit

also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America, showing that this geographic unit has a 90-95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

Overall, although naturally fragmented and patchily-distributed, lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway) development and evidence of minor genetic differentiation among lynx subpopulations (see *Lynx Status*, below), past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

A possible exception may be in the Garnet Mountains, which are known to have supported a small number of resident lynx in the 1980s and recently from 2002-2010, but where more recent surveys and research trapping efforts have failed to detect lynx (Squires *in* Lynx SSA Team 2016, p. 20; also see Lynx Status, below). This small and relatively isolated island of lynx habitat (Squires 2014, p. 4) at the southern end of this unit is thought to be capable of supporting 7-10 lynx home ranges (Squires 2016, pers. comm.). The BLM (2004, pp. 4-5) contrasted current and historical distributions of lynx habitats in the Garnets and found that early- successional stands (future hare and lynx foraging habitats) were at 25-50 percent of the historic condition in lower- elevation (1,370-1,830 m [4,500-6,000 ft]) lynx habitats, and 10-30 percent in higher- elevation (1,675-2,130 m [5,500-7,000 ft]) habitats. Late- successional (mature multistoried) stands (25-75 percent of historical condition) and large (> 100 ha [250 ac]) patches (25-50 percent of historical condition) were also underrepresented at lower elevations, but at higher elevations, late- successional stands and large patches exceeded 200 percent and 100 percent of historical conditions, respectively. Lower elevation habitats were fragmented by roads and past management practices (i.e., timber harvest), while higher-elevation habitat patterns were attributed to the absence of disturbance, including fire (BLM 2004, p. 5), though fire absence was not attributed to suppression.

As discussed for the GYA in section 2.3.2.2, above, whether the recent absence of lynx in the Garnets represents the extirpation of a previously- persistent small resident population (and, therefore, a contraction in the range of resident lynx in this unit) or a temporary “winking off” of a small peripheral population that would be expected in a mainland-island metapopulation structure is uncertain and perhaps irresolvable. If residency was intermittent historically, the current absence of lynx might be a natural condition related to the area’s naturally fragmented habitats and generally low hare densities - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. If so, future intermittent lynx occupancy would be expected, but only if lynx dispersing from a source

population immigrate to the Garnets when habitat conditions and hare densities return to more favorable levels. Conversely, if the Garnets historically supported a small but persistent population that was recently extirpated, it may suggest that the alteration of the historic distribution of some habitats in some parts of the range, described above, was enough to tip the quality of the area's habitat from capable of supporting a small resident population to no longer capable of doing so.

In summary, almost all lands in this unit are managed to conserve lynx and hare habitats in accordance with federal, State, and Tribal regulations and management direction, conservation easements, and an approved HCP. Much of the area consists of designated federal and Tribal wilderness areas and other nondevelopmental land use allocations, where management activities with the potential to adversely affect lynx generally do not occur. On lands with development allocations, USFS, BLM, and State management are based on plans that incorporate the conservation guidance identified in the LCAS as informed by more recently-available scientific information. The State and TNC, working with other conservation partners, have bought or acquired conservation easements on large tracts of high-quality private lands in the unit that are known or suspected to be occupied by resident lynx. These efforts and management across multiple ownerships likely preclude landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places, as described above for the Garnet Mountains. Because lynx habitats in this unit, like most other areas of the DPS range, are naturally highly-fragmented, and most have hare densities that barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit although, as described in section 2.3.2.2 above, it is thought to be capable of supporting perhaps 200-300 lynx (Squires *in* Lynx SSA Team 2016, p. 41). This is substantially fewer than previous estimates of more than 1,000 lynx, which were based on a habitat area/ density index and broad assumptions regarding habitat suitability and lynx distribution (65 FR 16058) that are not supported by current understanding of lynx habitat requirements. As described above, habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Although the exact distribution of resident lynx remains uncertain, this unit has a long and continuous history of lynx occurrence and evidence of reproduction (McKelvey *et al.* 2000, pp. 224-225; Squires and Laurion 2000, pp. 346-348; Squires *et al.* 2008, entire; Squires *et al.* 2013, entire; ILBT 2013, p. 57; 65 FR 16058; 68 FR 40090; 74 FR 8643; 79 FR 54825). Genetic analyses revealed minor fine-scale genetic sub-structuring among lynx subpopulations in the southern (Garnets), central (Seeley Lake), and northern (Purcells) parts of this unit, suggesting limited interaction among lynx in those areas (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5; Squires *in* Lynx SSA Team 2016, p.

20). Lynx in this unit likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia, but the extent to which lynx persistence in this area may rely on immigration from Canada is unknown, and there is no indication of substantial immigration (irruptions) of lynx from Canada into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20).

From 1998 to 2007, researchers with the Forest Service's Rocky Mountain Research Station in Missoula trapped and radio-marked 175 lynx in northwestern Montana and collected nearly 170,000 GPS and over 3,000 VHS telemetry locations documenting lynx movements, resource use, survival, and productivity (Squires *in* Lynx SSA Team 2016, p. 20). From 1999-2007, litter sizes averaged 2.24 kittens/litter (N = 33) in the Seeley Lake area and from 2003-2007, 2.95 kittens/litter (N = 22) in the Purcell Mountains. In Seeley Lake, 61 percent of breeding-age females (N = 52) produced kittens; in the Purcells, 83 percent of females (N = 28) produced kittens. Recent research (Kosterman 2014, entire) suggests that the probability that a female produces a litter and initial litter size are correlated positively with mature forest connectivity and negatively with fragmentation in female home ranges (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix A). Annual survival rates for subadult and adult female lynx were 0.52 and 0.75, respectively, in Seeley Lake, and 0.68 and 0.85, respectively, in the Purcells. There was no evidence of cyclicity in these vital rates, and no indication of substantial immigration of lynx into these study areas from Canada. Starvation, predation by mountain lions, and human-caused deaths each accounted for roughly one-third of documented sources of lynx mortality. Population viability analyses yielded population growth rates (λ) of 0.92 for the Seeley Lake area (i.e., declining population trend, 1999-2007) and 1.16 for the Purcells (increasing trend, 2003-2007). However, as described in section 2.2.2, above, estimates of λ in a cyclic Canadian population of lynx ranged from 2.03 (annual doubling) when hares were abundant to 0.10 (order of magnitude decline) after hare populations crashed (Slough and Mowat 1996, p. 952, Table 4), and the natural range in λ that would be expected among peripheral, isolated, or semi-isolated and non-cyclic or weakly-cyclic lynx populations in the DPS versus those that would signal long-term population decline or instability is unknown.

As described above, lynx distribution in this unit may have contracted with the recent apparent disappearance of resident lynx from the Garnet Mountains in the southern part of the unit. Lynx were documented in the Garnets in the 1980s and from 2002-2010, but no lynx were detected during snow-track and camera-trap surveys in winter 2014-2015 (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix 5). This area is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016 pers. comm.); 5 lynx were monitored via telemetry in 2002, 3 in 2003-2004, 2 in 2005, and single lynx each year in 2006, 2007, and 2010 (Squires *in* Lynx SSA 2016, Appendix 5 [2015 10 14 - 8, p. 26]). As described in section 2.3.2.2 and above, whether the recent absence of lynx from this part of the unit represents the extirpation of a small but previously persistent population (and, therefore, a permanent contraction of lynx distribution in this unit) or the temporary "winking off" of a peripheral subpopulation that may become "winked on" again in the future is unknown and perhaps irresolvable.

Snow-tracking, hair-snare, and camera-trap surveys in other parts of this unit since the DPS was listed continued to detect lynx on the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests (USFS 2015, pp. 9-27). On the Flathead, the USFS Rocky Mountain Research Station(RMRS) trapped and radio-marked 7 lynx (3 females, 4 males) in the Flathead River watershed from 2010-2015, and surveys detected lynx in several other areas including the Salish Mountains, the area just south of Glacier National Park, and in the vicinity of Hungry Horse Reservoir (USFS 2015, pp. 10-11). The Swan Lake District in the southern part of the Flathead, along with the Seeley Lake District of the Lolo National Forest and the Lincoln District of the Helena National Forest, is part of the 6,070-km^2 (2,344-mi^2) Southwestern Crown of the Continent, which was intensively surveyed from 2012-2014 by the Southwestern Crown Carnivore Monitoring Team (SCCMT 2014, entire). The SCCMT conducted snow track surveys and used hair snares, bait stations, and camera traps to detect lynx in 36 of the 82, 8 x 8 km (5 x 5 mi) grid cells they surveyed (SCCMT 2014, pp. 3, 17-20). The surveys resulted in collection of DNA that allowed identification of 18 individual lynx (5 females, 13 males), 13 of which were new to regional lynx databases (SCCMT 2014, pp. 3, 17-20).

On the Helena National Forest, few lynx have been detected outside the Lincoln District/ Southwest Crown described above. In the south MacDonald Pass area, just south of this SSA unit and south of designated critical habitat, an individual male lynx was verified by DNA evidence over four winters (2007-2011), and an individual female was verified in the same area in the winter of 2008-2009 (Gehman *et al.* 2011, p. 21; USFS 2015, p. 27). Other surveys on the Helena failed to detect lynx in the disjunct Big Belt and Elkhorn Mountains, although telemetry data indicated that three lynx released in Colorado passed through the Big Belts in 2004-2006 (USFS 2015, pp. 26-27). Likewise, during snow tracking surveys on the Lolo in 2010-2011 (prior to the Southwestern Crown monitoring described above), lynx were also confirmed on the Seeley Lake District in the eastern part of the forest, but no lynx were documented on the Missoula or Ninemile districts, nor on the Superior and Plains/Thompson Falls districts in the western part of the forest (USFS 2015, pp. 12-14). The USFS concluded that lynx presence in districts other than Seeley Lake is extremely rare and likely represents occasional dispersing lynx (USFS 2015, p. 21).

On the Kootenai National Forest, RMRS research efforts continued to document the long-term presence of lynx, where trapping and radio-marking efforts yielded 50,000-60,000 lynx telemetry locations from 2003-2012 (USFS 2015, p. 10). On the Lewis and Clark National Forest, lynx are considered “still present” in the Rocky Mountain Front portion of the forest, which is within this geographic unit and designated critical habitat, and snow track surveys from 2010-2013 in the disjunct Little Belt and Crazy Mountains documented the continued absence of resident lynx in those ranges (USFS 2015, pp. 25, 27-34). On the Idaho Panhandle National Forest, surveys detected individual lynx in the Selkirk Mountains in 2010 and 2011 and in the Purcell Mountains in 2012. All detections were within 15 miles of the Canada-U.S. border (USFS 2015, p. 10). No lynx were detected during surveys in 2007 or 2013-2014, and snow surveys were not done in 2015 because of poor snow conditions (USFS 2015, p. 9). However, in 2012-2014 three lynx were incidentally trapped on the Idaho Panhandle (one in 2012 in the Purcells, and two in 2014

in the Cabinet Mountains), and another was documented by a Service grizzly bear trapping crew in the Purcells in 2014 (USFS 2015, pp. 9-10; U.S. District Court ID 2016, pp. 6-7).

In summary, although the number of lynx in this geographic unit is uncertain, resident lynx appear to remain broadly distributed throughout most of the unit. The recent apparent absence of lynx in Garnet Mountains may indicate extirpation of a small resident population and a contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure. Lynx are rarely detected on surveys on other national forests (or parts of those above) that are outside but adjacent to this geographic unit (Patton 2006, entire; USFS 2105, pp. 1-9, 25-34), suggesting that these areas lack the habitat features and/or landscape-level hare densities necessary to support resident lynx populations (79 FR 54818-54820).

Factors Affecting Current Conditions: *Regulatory Mechanisms* - Federal management activities (especially timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. For example, as described above in *Habitat Status* and *Lynx Status*, past timber harvest/management and associated road construction may have fragmented, reduced the amount, and altered the distribution of lynx habitats in the Garnet Mountains, perhaps contributing to the apparent recent loss of that area's ability to support resident lynx.

Currently, as described above and in section 3.1, all federal and Tribal lands, most State lands, and large blocks of private or formerly-private land in this unit are managed for the conservation of lynx habitats, and much of the unit is in designated wilderness or other nondevelopmental land-use allocations. Regulatory mechanisms and conservation measures associated with these management strategies are intended to conserve and restore lynx and hare habitats across large landscapes and multiple ownerships. Although their effectiveness has not be quantitatively evaluated, and despite the potential extirpation of a small population in the Garnets, lynx habitats and resident lynx appear to remain well distributed throughout most of this unit.

Other regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, 16 lynx are documented to have been incidentally trapped in Montana, with 13 of those occurring before 2008, when more protective regulations were put in place (MTFWP 2016, pp. 5-10). Of the 16, eight were released uninjured, one was released with an injury, and seven were killed; all incidences of mortality occurred prior to 2008 and the implementation of the more protective regulations (MTFWP 2016, p. 5). In Idaho, in addition to the three lynx incidentally trapped on the Idaho Panhandle National Forest from 2012-2014 (described above under *Lynx*

Status), one other lynx was incidentally trapped in 2012 on the Salmon-Challis National Forest further south (U.S. District Court ID 2016, p. 6).

Although lynx are legally trapped in Canada adjacent to this unit in southern Alberta and southern British Columbia, trapping there is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Environment Canada 2014, entire; Vashon 2015, pp. 5-6). Lynx harvest in Alberta varied from about 4,000 to 14,000 annually in the late 1970s and early 1980s, but declined to fewer than 2,000 for most years from 1984-2000, and restrictive quotas and season closures were implemented beginning in the late 1980s (Poole and Mowat 2001, pp. 16, 28). Similarly, harvests in British Columbia peaked at over 12,000 in the early 1960s and over 8,000 in the early 1970s, then declined to fewer than 2,000 for most years from the mid-1980s until the year 2000 (Hatler and Beal 2003, p. 2). Whether, and if so to what extent, trapping in Canada may influence lynx dispersal across the border and into this geographic unit is unknown; however, such dispersal was documented historically when harvest levels in Canada were much higher than under current management.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Hall and Fagre 2003, entire; Mote 2003, entire; Fagre 2005, entire; Knowles *et al.* 2006, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Squires *in* Lynx SSA 2016, p. 20; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities, even in areas considered high-quality habitat for this DSP unit, often appear to barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 90-95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et*

al. 2010. pp. 607, 609). Although insect outbreaks have affected some parts of the DPS, no major outbreaks have been documented in lynx habitats in this unit (Lynx SSA Team 2016, p. 41).

Vegetation Management - As elsewhere in the DPS range, timber harvest and related vegetation management (precommercial thinning and other silvicultural techniques designed to optimize forest products outputs; ILBT 2013, pp. 71-72) are the dominant land uses potentially affecting lynx habitats in this unit (68 FR 40075, 40092; 79 FR 54825). As described in section 3.3, above, these activities can reduce hare and lynx habitats by reducing horizontal cover and altering natural disturbance regimes and forest successional patterns. In this unit, precommercial thinning was shown to reduce short-term hare abundance (Griffin and Mills 2007, entire) and appeared to influence lynx movements (Squires *et al.* 2013, p. 192-194), and lynx rarely traveled across recent clearcuts or other large openings, especially in winter (Squires *et al.* 2010, p. 1654; ILBT 2013, p. 77). However, as described under *Habitat Status*, above, these activities on federal lands, which account for most of the lands in this unit, occur only on lands with developmental allocations and historically appear to have impacted only a small proportion of potential lynx habitats in this unit (65 FR 16072; 68 FR 40093). Additionally, timber harvest levels on federal lands in the West, including the Northern Rockies, and specifically with regard to “lynx forest types,” had declined consistently and dramatically for a decade or longer prior to the DPS being listed (68 FR 40093), and have remained at levels much lower than those from most of the previous century. Despite some likely localized impacts, past vegetation management does not appear to have broadly diminished this unit's ability to support resident lynx, although, as described above, it may have contributed to the current absence of a small number of resident lynx from the Garnet Mountains. Also as described above, current vegetation management in this unit on all federal, most State and Tribal, and some private lands, is conducted in accordance with formally amended USFS and BLM management plans, an approved State HCP, Tribal regulations, and conservation easements designed to avoid or minimize impacts to lynx habitats, especially important hare and lynx winter foraging habitats.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, where about 15 percent (4,172 km^2 [1,611 mi^2]) of the unit has burned from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20), likely in response to climate warming and related increases in drought conditions (e.g., Harvey *et al.* 2016, entire; Westerling 2016, entire). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit’s ability to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction. In the Northern Rocky Mountains, the forests upon which lynx depend have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and

these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx (with the possible exception of the Garnet Mountains). Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Idaho (1) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. This unit is directly connected to lynx habitats and populations in southwestern Alberta and southeastern British Columbia, where lynx habitats are also (like Montana and Idaho) patchily-distributed and generally support low hare densities, and where some lynx populations may be ephemeral and the persistence of others reliant on periodic influx of immigrants (Apps 2007, pp. 81, 95-104). Additionally, connectivity between this geographic unit and lynx habitats and populations in southern Alberta and southern British Columbia may be facilitated by only a few predicted corridors that extend south from the international border (Squires *et al.* 2013, pp. 187, 191-193).

Although lynx occurrence and harvest records in this geographic unit reflect the unprecedented irruptions of lynx from Canada into the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 224-226, 232-242), there is no evidence of irruptions of lynx into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). This is supported by lynx trapping records from Canada, which suggest that the magnitude of lynx populations cycles in Alberta and British Columbia dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Poole and Mowat 2001, p. 28; hatler and Beal 2003, p. 2; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which would be expected to alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a

gradual decline of a resident lynx population that needs but is not receiving adequate immigration. In contrast, the growth rate estimated for the lynx population in the Purcell Mountains in the northwestern part of this unit (λ = 1.16, increasing trend 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) suggests that the level of immigration, if necessary for demographic stability, has been adequate or that productivity and recruitment have been high enough to offset potentially diminished immigration. It is also possible that, despite the documented historical intermittent (cyclic) influxes of lynx from Canada into lynx populations in this geographic unit, immigration does not contribute meaningfully to the demographic stability of these populations. If that is the case, the estimated growth rates suggest that recruitment has failed to offset mortality in the Seeley Lake population but that it has more than done so in the Purcell Mountains population.

4.2.4 Unit 4 - North-central Washington

Unit Description: This geographic unit is located in the northern Cascade Mountain Range of north-central Washington in portions of Chelan and Okanogan Counties and includes mostly Okanogan-Wenatchee National Forest lands as well as BLM lands in the Spokane District that were designated as critical habitat (Unit 4) for lynx in 2014 (79 FR 54825). The unit also includes State Forest lands (portion of the Loomis State Forest) that were excluded from designation as critical habitat (79 FR 54825). It encompasses approximately 5,176 km^2 (1,988 mi^2), with ownership that is 91.5 percent federal (USFS, BLM), 8.2 percent State, and 0.3 percent private lands; there are no Tribal lands. This area was occupied at the time lynx was listed and is currently occupied by the species. Evidence from recent research and DNA analysis shows lynx distributed within this unit, with breeding being documented. Although researchers have fewer records in the portion of the unit south of Highway 20, this area contains boreal forest habitat and the components essential to the conservation of the lynx. Further, it is contiguous with lynx habitat north of Highway 20, particularly in winter when deep snows close Highway 20. The northern portion of the unit adjacent to the Canada border also appears to support few recent lynx records; however, it is designated wilderness, so access to survey this area is difficult. This northern portion contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia directly north of this unit.

As it is throughout the range of lynx in the contiguous U.S., maintaining connectivity with Canada is important to lynx populations in northern Washington and the Cascade Mountains. Singleton *et al.* (2002, entire) evaluated landscape permeability for large carnivores in Washington. They reported broad landscape permeability for lynx between the Thompson River watershed in British Columbia and the U.S. portion of the northern Cascades (Singleton *et al.* 2002, p. 46). According to the LCAS, connectivity currently appears functional, as lynx dispersal from Washington into Canada was recently documented. A male lynx radio-collared in 2008 in the Loomis State Forest remained there until late winter in 2009, when it dispersed north into Canada toward Hope, British Columbia, and then headed north-east toward Kamloops where it appeared to establish a home range just southeast of Kamloops. This individual was later

trapped and killed in British Columbia, highlighting the need for cooperation and shared management goals across political boundaries (LCAS 2013, p. 65).

Several areas adjacent to this geographic unit (e.g., Kettle Range, the Wedge, Little Pend Oreille, Selkirk Mountains of northeast Washington) are known or thought to support a small number of lynx, at least intermittently. One of these areas in particular (Kettle Range) contains the second largest block of potential lynx habitat in Washington comprising approximately 987 km^2 (381 mi^2), which is significantly smaller than the North Cascades that supports approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (Stinson 2001, p. 18). Historically, although the Kettle Range supports a fairly small block of lynx habitat (relative to other geographic areas supporting persistent lynx populations), it was considered to be a stronghold for lynx in Washington (Stinson 2001, p. 14). The Kettle Range was suspected to have supported a resident population until about 30 years ago when over-trapping may have resulted in their extirpation from the mountain range (Koehler *et al.* 2008, p.1523). For example, lynx were consistently trapped in the Kettle Range in the 1960s, 1970s, and 1980s. In the Kettle Range, a total of 81 lynx were trapped from 1961 through 1986. One lynx was harvested in 1963, 3 in 1966, 7 in 1967, 2 in 1969, 26 in 1970, 14 in 1976, and 17 in 1977. A single lynx was taken each year in 1980, 1983, 1985, and 1986 (Stinson 2001, p. 63). Prior to 1961, lynx trapping records were not maintained in Washington. Beginning in 1978, trapping seasons in Washington for lynx were reduced to one month. In 1987 a restricted permit system was implemented, and in 1990 a statewide closure on lynx trapping was implemented (Service 2008).

Lynx habitat in the Kettle Range is limited in size and capable of supporting few lynx. According to Koehler *et al.* (2008, p. 1523), the Kettle Range could support between 10 to 23 lynx based upon a lynx density of 2.3 lynx/100km^2 and 400 km^2 (154 mi^2) to 987 km^2 (381 mi^2) of lynx habitat. It should be noted that the lynx density estimate was derived from research conducted in the Cascade Range within a large area of contiguous, high quality habitat (Koehler 1990, pp. 845, 847). Lynx habitat in the Kettle Range is much smaller and likely more fragmented, and thus may not be capable of supporting a density of 2.3 lynx/100 km^2. The Kettle Range is also somewhat isolated from other lynx habitats in Washington (e.g., the Cascades) and British Columbia. The Kettle Range is separated from the Cascades in Washington by low elevation valleys dominated by shrub-steppe and Douglas-fir and ponderosa pine forests (Koehler *et al.* 2008, p. 1523), and from British Columbia by the Kettle River Valley (Stinson 2001, p. 20) and a major highway corridor with associated fence in British Columbia (Koehler *et al.* 2008, p. 1523). These natural topographic and anthropogenic features may present impediments to lynx movement between the Kettle Range and the Cascades and British Columbia, making natural recolonization of the Kettle Range by lynx difficult. Thus, it may be difficult for lynx to reestablish a persistent and viable resident breeding population in the Kettle Range.

Habitat Description: In the northern Cascades most lynx occurrences are associated with the Rocky Mountain Conifer Forest (Aubry *et al.* 2000, p. 379; McKelvey *et al.* 2000, p. 246) at elevations between 1,400 m (4,593 ft) and 2,150 m (7,053 ft) (McKelvey *et al.* 2000, p. 322; Stinson 2001, p. 9). Within this area lynx primarily use forests dominated by Engelmann spruce,

subalpine fir, or lodgepole pine on mild to moderate slopes (less than 30 degrees), and avoid Douglas-fir and ponderosa pine forests, forest openings, recently burned areas with sparse canopy and understory cover (less than 10 percent), low elevations [less than 915 m (3,000 ft)], and steep slopes (greater than 30 degrees) (Koehler *et al.* 2008, pp. 1518, 1521; Maletzke 2004, pp. 16-17). Similar to the northern Rocky Mountains, lynx habitat in the Cascades is naturally fragmented (Koehler *et al.* 2008, p. 1523). Disturbance is common in boreal forests, and fires and insect epidemics are major drivers of this disturbance, but other factors including wind and disease also contribute to the process of disturbance (Agee 2000, p. 47). Fire return intervals in the north Cascades ranges between approximately 100 to 250 years (Agee 2000, p. 50).

Snowshoe hares are the primary prey of lynx throughout their range in North America (Mowat *et al.* 2000, p. 267) comprising 35-97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Lynx also consume other prey species, including red squirrels, mice, voles, grouse, ptarmigan, and other species of mammals and birds, especially during summer or when snowshoe hare population densities decline (Mowat *et al.* 2000, pp. 267-268). Koehler (1990, p. 848) found snowshoe hares were the primary prey of lynx in the north Cascades of Washington occurring in 23 of 29 (79 percent) lynx scats examined, but the remains of red squirrels were identified in 7 of the 29 (24 percent) lynx scats, as were the remains of other species including deer and mice. Von Kienast (2003, p. 39), who also conducted a lynx study in the north Cascades of Washington, found snowshoe hares in 87% (40 of 46) of lynx scats, while red squirrels were identified in 28% (13 of 46) of lynx scats.

Results of lynx research in the northern portion of its range suggest that a minimum density of 0.5-1.0 hares/ha (0.2-0.4 hares/ac) is needed to support lynx reproduction, but it is unknown if a similar snowshoe hare density is required to support lynx reproduction in the southern portion of its range (Ruggiero *et al.* 2000b, p. 446). In the northern portion of lynx range (i.e., the taiga) peak snowshoe hare densities regularly exceed 4-6 hares/ha (1.6-2.4 hares/ac), and cycle as low as 0.1-1 hares/ha (0.04-0.4 hares/ac) (Hodges 2000, pp. 119-120). In the southern portion of lynx range (e.g., the U.S.) snowshoe hare densities are low compared to those in northern regions (Aubry *et al.* 2000, p. 375). Walker (2005, p. 20) estimated an average snowshoe hare density of 0.89 hares/ha (0.36 hares/ac) with a range of 0.03 to 4.85 hares/ha (0.01 to 1.94 hares/ac) in north central Washington (i.e., the Cascades). The Washington Department of Natural Resources (WADNR) found snowshoe hare densities between 0.3 and 0.7 hares/ha (0.1 and 0.3 hares/ac) on the Loomis State Forest (WADNR 2006, p. 87).

Lynx distribution is nearly coincident with the distribution of snowshoe hares (McCord and Cardoza 1982, entire; Bittner and Rongstad 1982, entire), and lynx occupy habitats where snowshoe hares are abundant (Koehler and Aubry 1994, p. 84). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448). Average annual snowfall is consistent throughout this unit and is approximately 291 cm (114.5 in) (https://snowfall.weatherdb.com/d/a/Washington; accessed 4/27/2016).

Habitat Status: The range of lynx in the contiguous U.S. is broadly delineated by the distribution of the southern extensions of boreal forest. However, the complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with naturally dynamic habitat, make it difficult to precisely delineate the historic range of lynx in the U.S. (68 FR 40084). McKelvey *et al.* (2000, pp. 245-246) described the historic range of lynx in the western U.S., encompassing at least 75 percent of lynx occurrences, as associated with the Rocky Mountain Conifer Forest containing the primary vegetation types of Douglas-fir and western spruce/fir forests. These western spruce fir forests represent the southern extension of boreal forests into the U.S. (Agee 2000, pp. 40-42, 46). The amount of boreal forest habitat in the contiguous U.S. has not changed substantially in the past 100 years (68 FR 40085).

However, while the boreal forest may not have changed substantially within the past 100 years (i.e., permanent or long-term reductions in the quantity or size), it is naturally dynamic with fire and insects representing major disturbance processes (Agee 2000, p. 47) that can create areas temporarily unsuitable for lynx through regeneration of forested stands to early successional conditions (Agee 2000, pp. 62-63). In 2001, the Washington Department of Fish and Wildlife (WDFW) estimated there was approximately 8,923 km^2 (3,445 mi^2) of potential lynx habitat within this geographic unit. Several wildfires affected lynx habitat in the north Cascades during the middle 1990s and early 2000s: 1994 Whiteface Burn (1,554 ha (3,840 ac)); 1994 Thunder Mountain Fire (3,686 ha (9,108 ac)); 2001 Thirty-Mile Fire (2,565 ha (6,338 ha)); and 2001 Farewell Fire (32,278 ha (79760 ac)) (Vanbianchi 2015, p. 23). Subsequent to these fires and incorporating new science on lynx habitat use, Koehler *et al.* (2008, pp. 1521-1522) estimated this geographic unit contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on studies conducted from 2002 through 2004. More recent wildfires, including the 2006 Tripod Fire (70,644 ha (175,656 ac)) (Vanbianchi 2015, p.23), have affected approximately 1,000 km^2 (386 mi^2) of lynx habitat within this geographic unit (Lynx SSA Team 2016, p. 21). Cumulatively, over the past 2 decades these wildfires have burned greater than 50 percent of the suitable lynx habitat within this geographic unit (Koehler *et al.* 2008, p. 1523). These acres are expected to regenerate back into suitable lynx habitat, but it may take several decades for this to occur.

Lynx Status: In Washington, there is little information on the status of the lynx population prior to the early 1960s (Stinson 2001, p. 13). From 1960-61 to 1990-91 a total of 234 lynx were harvested in Washington, with the most lynx trapped in Ferry County (35 percent of the 234), followed by Okanogan (23 percent) and Stevens (10 percent) counties (Stinson 2001, p. 13). The WDFW identified six lynx management zones (LMZs) in Washington: Okanogan, Vulcan-Tunk, Kettle Range, The Wedge, Little Pend Oreille, and Salmo-Priest (i.e., essentially the Selkirk Mountain Range in northeast Washington (Stinson 2001, p 14). In 2001, the WDFW considered lynx to be present in the Okanogan, Kettle Range, Little Pend Oreille, and Salmon-Priest LMZs; at that time lynx had not been detected in the Wedge LMZ since 1987 nor the Vulcan-Tunk LMZ since 1990 (Stinson 2001, p.15).

In 2001, based on data collected from lynx telemetry studies conducted in the Cascade Range during the 1980's, the WDFW estimated that Washington contained approximately 12,579 km^2 (4,857 mi^2) of lynx habitat which could theoretically support up to 238 lynx (based on a lynx

density of 2.5 lynx/100 km^2) (Koehler 2008, p. 1518; Stinson 2001, p. 16). However, based on professional opinions of individuals knowledgeable about lynx and lynx habitat, the WDFW adjusted this number down suggesting that Washington likely supported fewer than 100 individual lynx (Stinson 2001, p. 16). More recently, Koehler *et al.* (2008, p. 1523), estimated there was approximately 3,800 km^2 (1,467 mi^2) of lynx habitat in Washington potentially supporting up to 87 lynx. This more recent population estimate was based on a study investigating lynx habitat use in the Okanogan from 2002 to 2004, and used a lynx density estimate of 2.3 lynx/100 km^2 derived from a radio-telemetry study conducted on lynx in the Cascades from 1985-1987 (Koehler 1990, pp. 845-847). However, the study area in which the 2.3 lynx/100 km^2 density estimate reported by Koehler (1990, p.847) was derived is located in an area of the northern Cascades known as the "Meadows". During the time of Koehler's (1990, entire) study the Meadows provided some of the best lynx habitat in Washington, whereas most other lynx habitat in Washington is lower in elevation and more highly fragmented (Walker 2005, pp. 3, 6). Thus, the lynx densities Koehler observed in his study area in the Meadows may not translate to lynx densities throughout the rest of lynx habitat in Washington, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines. Thus, applying Koehler's estimated lynx density uniformly throughout Washington, may overestimate the overall lynx population capable of being supported in Washington.

Relative to the Okanogan LMZ (i.e., the north Cascades), which supports the only known persistent breeding population of lynx in Washington State, in 2001, the WDFW estimated the LMZ could support a maximum of 149 lynx (Stinson 2001, p. 16). This number was derived by estimating that the LMZ contains approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (which was decreased by 33 percent to account for unsuitable areas) combined with an average lynx population density estimate of 2.5 lynx/100km^2 derived from two studies conducted in the 1980s (Stinson 2001, p. 16). The estimated quantity of lynx habitat was based on mapping areas supporting the forest-type and physiographic characteristics identified as being used by lynx during telemetry studies conducted in the 1980s (Koehler *et al.* 2008, p. 1518), irrespective of the current condition (successional stage, or stand type, structure, or age, etc.) of the habitat. The estimation of lynx habitat was based purely on forested areas potentially supporting a forest-type potential of subalpine fir/Engelmann spruce, and the physiographic characteristics of elevations greater than 1,400 m (4593 ft) on mild to moderate slopes (Koehler *et al.* 2008, p. 1518), and did not consider whether the area was recently burned, harvested, etc. Recognizing that new information on lynx and snowshoe hare habitat use patterns had been learned since the 1980's, and that several large, stand-replacing fires had burned in lynx habitat, Koehler *et al.* (2008, entire) conducted a lynx telemetry study in the Okanogan from 2002 to 2004 to reassess the suitability of lynx habitat. They estimated that the Cascades contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on mapping areas supporting Engelmann spruce/subalpine fir forests with moderate canopy cover on flat to moderate slopes at elevations from 1,525 m (5003 ft) to 1,829 m (6000 ft) (Koehler *et al.* 2008, pp. 1521-1522). Therefore, at that time and using Koehler's (1990, p. 847) lynx density estimate of 2.3 lynx/100 km^2, the Cascades could theoretically support approximately 55 individual lynx.

From 1985 to 1987, the movements of five adult male and two adult female radio-collared lynx were monitored by Koehler (1990, entire) in the Cascades of north-central Washington. During the study two kittens were also captured and ear-tagged (Koehler 1990, p. 847). Results of the study indicated female average home range size was 39 km^2 (15 mi^2) and average male home range size was 69 km^2 (27 mi^2). Based on occupancy of the 640 km^2 study area by 15 adult lynx, adult lynx density was estimated to be 2.3 adults/100 km^2. Annual adult survival rates of the radio-collared lynx were 0.73 in 1986 and 1.00 in 1987, and kitten mortality was high at 88 percent with only 1 of 8 known kittens surviving its first year (Koehler 1990, p. 847).

As stated previously, fire is a common disturbance factor in boreal forests (Agee 2000, p. 47). Fire return intervals within western subalpine fir forests in the Cascades range from 109 to 250 years (Agee, 2000, p. 50) with typically high fire intensities in lynx habitat resulting in extensive areas of regenerating forest (Agee, 2000, p. 53). Maletzke assessed the effects of recent fires in the Cascades and their potential impacts to the lynx population there as follows:

> "From 1990-2002, there were about 2,600 km^2 of lynx habitat in the Okanogan (Eastern Cascades) area, and female home ranges were estimated at 39 – 41 km^2, suggesting the potential to support roughly 90-115 resident females (home ranges include "matrix" or non-habitat). By 2014, habitat had been reduced by fire to about 1,600 km^2, and habitat loss and fragmentation resulted in female home ranges increasing to an estimated 91 km^2, with a potential to support roughly 27 resident females" (Lynx Workshop Report 2016, p. 21).

Therefore, using Maletzke's method and assuming a 2:1 sex ratio of females to males, the total theoretical lynx population that may have been supported in the Cascades prior to 2002 may have ranged between 135 and 172 individual lynx. Subsequent to the fires the total theoretical lynx population potentially supported in the Cascades has been reduced to approximately 40 individual lynx, which potentially represents a 70 percent to 77 percent decline in the lynx population. Note: while the area (lynx habitat in the Cascade range) used to generate the population estimate of 55 lynx in the Cascades prior to the fires based on Koehler's (1990, p. 847) lynx density estimate is the same as the area used by Maletzke to generate his population estimate of 90 – 115 resident females based on simulated female home ranges with an empirically derived size and arbitrary minimum threshold of habitat, the two dissimilar population estimates used differing methodologies, and thus the population estimates themselves are not comparable. However, using Koehler's lynx density estimate of 2.3 lynx/100 km^2 and applying it to the 1,600 km^2 of lynx habitat remaining after the fires results in an estimated lynx population of approximately 37 individual lynx, which represents an approximate 33 percent reduction in the lynx population. Further informing the effects of these recent fires in the Cascades on lynx habitat is illustrated by evaluating the average size of a female lynx home range prior to and after the fires. Prior to the fires, Koehler (1990, p. 847) estimated an average female lynx home range size of 39 km^2 (15 mi^2), whereas after the fires Maletzke estimated the average female home range size had increased to 91 km^2 (35 mi^2) (Lynx Workshop Report 2016, p. 21). The important point is the recent large, stand replacing fires in the Cascades has resulted in significant temporary losses of lynx habitat, and thus the ability of the Cascades to support a persistent and viable reproducing lynx population may have been significantly impacted. The

areas impacted by these recent fires are expected to regenerate into suitable lynx habitat, but it may take 35-40 years to do so (Lynx Workshop Report 2016, p. 21).

Factors Affecting Current Condition: In 1993, lynx were classified by the Washington Fish and Wildlife Commission as a state threatened species (Stinson 2001, p. 22). On July 12, 2016, the WDFW recommended that the Washington Fish and Wildlife Commission uplist the lynx from a state threatened to a state endangered species (WDFW 2016, p.1). According to the Draft Washington State Periodic Status Review for the Lynx, the WDFW recommended listing the lynx as endangered due to: 1) observed range contraction in Washington following protection efforts; 2) the substantial loss of habitat in the last 20 years; and 3) the ongoing and anticipated threats to lynx population persistence.

Within Washington, the vast majority of lynx habitat is administered by the Okanogan/Wenatchee (OWNF) and Colville (CNF) National Forests. The North Cascades (aka the Okanogan LMZ in north-central Washington), which supports the only known, long-term persistent lynx breeding population in Washington, and within which critical habitat was designated for lynx in 2014 (79 FR 54782), is administered by the OWNF. Subsequent to listing lynx under the ESA, the Forest Service entered into a Conservation Agreement (CA) with the Service in 2000 (USFS and USFWS 2000, entire), which was revised and extended in 2006 (USFS and USFWS 2006, entire). The CA committed the ONWF and CNF to use the Lynx Conservation Assessment and Strategy (LCAS) for management of lynx and its habitat on their ownerships, and will remain in place until the forests amend or revise their individual LRMPs.

The LCAS, which was also developed pursuant to the listing by an interagency team comprised of USFS, BLM, Service, and NPS personnel, identified four primary risk factors potentially exerting population level effects upon the status of lynx: climate change, vegetation management, wildland fire management, and habitat fragmentation. To promote conservation of lynx and its habitat, the LCAS contains conservation measures addressing the identification and maintenance of lynx habitat (foraging, denning, and connectivity habitats) on federal lands. Toward this end, the LCAS recommends that federal land managers identify and map lynx habitat on their ownerships, and delineate LAUs containing the mapped lynx habitat, within which the effects of management actions on lynx habitat will be monitored and analyzed. The LCAS also recommends that the size of LAUs should be based on the average size of a female lynx home range and contain year-round habitat components (i.e., foraging and denning habitat). Thus, in Washington, and the north Cascades specifically, it appears that the single threat for which lynx were listed under the ESA (i.e., inadequacy of regulatory mechanisms) has largely been addressed through the development of the LCAS, and CA between the Forest Service and Service which commits the Forest Service, specifically for Washington the OWNF and CNF, to use the LCAS in the management of lynx habitat on their ownerships and when designing and implementing projects within LAUs.

The WADNR manages approximately 4 percent of the lynx habitat within portions of each of the delineated LMZs (WADNR 2006, p.9) in Washington State, including the Loomis State Forest that is located in the north Cascades of north-central Washington within the Okanogan LMZ. In

1996, the WADNR developed and implemented a Lynx Habitat Management Plan (1996 Lynx Plan) in response to listing of the lynx as a state threatened species by Washington State (WADNR 1996, entire). Subsequent to federally listing the lynx as threatened under the ESA, in 2006 the WADNR implemented a modified Lynx Habitat Management Plan (2006 Lynx Plan) incorporating new science into its 1996 Lynx Plan pertaining to lynx management (WADNR 2006, entire). Among other things, the WADNR 2006 Lynx Plan contains management standards and guidelines to avoid the incidental taking (as defined by the ESA) of lynx. These standards and guidelines address maintenance of lynx denning and foraging habitat, as well as habitat connectivity within and between LAUs and lynx populations within Washington (i.e., LMZs) and Canada.

For example, the WADNR 2006 Lynx Plan includes, among other things: (1) Encouraging genetic integrity at the species level by preventing bottlenecks between British Columbia and Washington by limiting size and shape of temporary non-habitat along the border and maintaining major routes of dispersal between British Columbia and Washington; (2) Maintaining connectivity between subpopulations by maintaining dispersal routes between and within zones and arranging timber harvest activities that result in temporary non-habitat patches among watersheds so that connectivity is maintained within each zone; (3) Maintaining the integrity of requisite habitat types within individual home ranges by maintaining connectivity between and integrity within home ranges used by individuals and/or family groups; and (4) Providing a diversity of successional stages within each LAU and connecting denning sites and foraging sites with forested cover without isolating them with open areas by prolonging the persistence of snowshoe hare habitat and retaining coarse woody debris for denning sites. The 2006 Lynx Plan also describes how WADNR will monitor and evaluate the implementation and effectiveness of the plan. The WADNR has been managing for lynx for almost two decades, and the Service has concluded that the management strategies implemented are effective. In the final revised critical habitat designation, published in the Federal Register on February 25, 2009 (74 FR 8657–8658), we determined that the benefits of excluding lands managed in accordance with the WADNR 2006 Lynx Plan outweighed the benefits of including them in the designation, and that doing so would not result in extinction of the species. We, therefore, again are considering excluding 164.2 mi^2 of lands managed in accordance with the WADNR 2006 Lynx Plan from the revised lynx critical habitat designation.

Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within the north Cascades (Koehler *et al.* 2008, p. 1523), which has significantly affected the status of and current viability of the lynx population within this geographic unit. As discussed below under *Potential Threats/Stressors/Factors Influencing Viability*, there is significant risk of potential future wildfires to further affect the viability of lynx in this geographic unit. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943), and as discussed below, climate change may similarly affect the future viability of lynx within this geographic unit.

4.2.5 Unit 5 - Greater Yellowstone Area

Unit Description: This geographic unit includes the parts of southwestern Montana and northwestern Wyoming the Service designated as critical habitat (Unit 5) for lynx in 2014 (79 FR 54825-54826). It encompasses approximately 23,691 km^2 (9,147 mi^2) in portions of Carbon, Gallatin, Park, Stillwater, and Sweetgrass Counties in Montana; and Fremont, Lincoln, Park, Sublette, and Teton Counties in Wyoming, with ownership that is 97.5 percent federal (USFS, NPS, and BLM); 2.2 percent private; and 0.3 percent State. This unit includes parts of Grand Teton and Yellowstone national parks and the Bridger-Teton, Custer-Gallatin, and Shoshone national forests, and lands managed by the BLM's Kemmerer and Pinedale Districts. It includes parts of the Absaroka, Beartooth, Gallatin, Gros Ventre, Salt River, Teton, Wind River, and Wyoming mountain ranges. This unit is not directly connected to lynx habitats and populations in Canada or to other DPS populations, although lynx dispersing from the north likely arrived intermittently into the area historically and, more recently, some lynx released into Colorado traveled into and through this unit (see Devineau *et al.* 2010, p. 526). Relative to other DPS lynx populations, this unit is about 145 km (90 mi) southeast of the Northwestern Montana/Northeastern Idaho unit, and roughly 400 km (250 mi) northwest of the Western Colorado geographic unit.

Habitat Description: In northwestern Wyoming and the GYA, lynx are generally associated with Englemann spruce-subalpine fir and lodgepole pine of the Rocky Mountain Conifer Forest vegetation class, as described above (Section 4.1.3) for the northwestern Montana, although this habitat and, thus, lynx typically occur at higher elevations (2,000-3,000 m [6,550-9,850 ft]) in the GYA (McKelvey *et al.* 2000a, p. 245; ILBT 2013, p. 60). Potential lynx habitat in much of the GYA is naturally marginal (patchier and composed in many places of drier forest types), with fewer shrubs and a more open understory, and generally low to marginal hare densities, resulting in a spatially-limited distribution of lynx with large home ranges (Squires *et al.* 2003, pp. 5, 12-13; 68 FR 40090; 71 FR 66010, 66029; 74 FR 8624, 8643–8644; Hodges *et al.* 2009, entire; Berg and Gese 2010, p. 1750; 79 FR 54796; Lynx SSA Team 2016, p. 45). Among the three national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 42 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123).

In Yellowstone National Park, 7,732 km^2 (2,985 mi^2; about 86 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 2,784 km^2 (1,075 mi^2; 31 percent of the park, 36 percent of lynx forest types) is estimated to be potential lynx habitat (68 FR 40086). However, hares were completely absent from more than 36 percent of surveyed stands in Yellowstone National Park, and 96 percent had estimated hare densities below the 0.5 hare/ha threshold thought necessary to support resident lynx (Hodges *et al.* 2009, 870, 873-877). In contrast, estimated hare densities were >= 0.48 hares/ha in all surveyed stands on the Bridger-Teton National Forest in the southern portion of the GYA, with highest densities (1.7 hares/ha) in 30-70-year-old regenerating lodgepole pine stands with dense horizontal cover, and densities of 1.2 - 1.6 hares/ha in mature multi-storied spruce-fir and mixed spruce-fir (containing aspen or lodgepole pine) stands (Berg *et al.* 2012, p. 1483). In the central Wyoming Range in the southern part of this unit, hare tracks were more abundant in seral aspen stands with a

significant spruce-subalpine fir component than in aspen stands with little or no spruce-fir, and hares appeared to be absent from pure aspen stands except where they bordered spruce/fir areas (Endeavor Wildlife Research 2009, p. 4). The only lynx den sites described for this unit (the natal den and a subsequent maternal den of one female in 1998) occurred in a mature subalpine fir-lodgepole pine forest in the Wyoming Range, where coarse woody debris and high sapling density provided dense horizontal cover (Squires and Laurion 2000, pp. 346-347).

Average annual snowfall in this unit ranges from about 127 cm (50 in) in Bozeman and 556 cm (219 in) in West Yellowstone, Montana, on the northern and northwestern peripheries of the unit, respectively, to 280-310 cm (110-122 in) in Alpine, Dubois, and Jackson, WY near the central and southern peripheries, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 8/17/2016). In potential lynx habitats on the Bridger-Teton National Forest in the southern half of this unit, deep snow persisted from late October through May (Berg *et al.* 2012, p. 1481).

Habitat Status: Potential lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 97 percent (23,109 km^2 [8,922 mi^2]) of this unit is in federal ownership, including 18,877 km^2 (7,292 mi^2) in national forests under USFS management, 3,944 km^2 (1,523 mi^2) in national parks managed by NPS, and 271 km^2 (105 mi^2) managed by BLM. As described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2008 and 2010 revised its RMPs for the Pinedale and Kemmerer districts, respectively, to include conservation measures and BMPs for lynx based on the LCAS (BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). On lands with developmental land-use allocations, these amended forest plans and the revised BLM RMPs provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently-applied framework for conserving and restoring important hare and lynx habitats.

As elsewhere in the DPS (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27), winter foraging habitat is likely the most limiting habitat for lynx in this unit, and denning habitat is not thought to be limiting. Standards, guidelines and BMPs in the NRLMD and in revised BLM plans restrict vegetation management activities that could reduce winter snowshoe hare habitat and direct the creation or retention of coarse woody debris in areas where denning habitat may be lacking (USFS 2007, Attachment 1, pp. 2-5; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America,

showing that most of this geographic unit has a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

This unit includes substantial areas in nondevelopmental land-use allocations, including (in addition to Yellowstone and Grand Teton national parks) the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie designated wilderness areas. Among the three national forests that contribute to this unit, 75 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34). Management activities in these areas are unlikely to adversely impact lynx and hare habitats.

Large parts of Yellowstone National Park burned in the extensive wildfires of 1988. Although the extent to which those fires may have impacted potential lynx habitats is uncertain, some of the burned areas may soon reach a stage of regeneration capable of supporting increased densities of hares, perhaps increasing the likelihood that lynx could reestablish and maintain home ranges in some parts of the park (Lynx SSA Team 2016, p. 45).

Because non-federal lands make up less than 3 percent of lynx habitats in this unit, it is unlikely that activities on those lands have impacted lynx populations or meaningfully influenced the unit's current capacity to support resident lynx.

Overall, although naturally fragmented and patchily-distributed, potential lynx habitat in this geographic unit appears to be largely intact relative to historic conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway, railroad) development, past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

In summary, much of this geographic unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental land-use allocations, where management activities with the potential to adversely affect lynx habitat generally do not occur. Almost all lands with developmental land-use allocations in this unit are managed by the USFS to conserve and maintain lynx and hare habitats under management plans that were formally revised in 2007 in accordance with the NRLMD and based on the scientific findings and conservation recommendations of the LCAS. A small proportion of lands with developmental allocations occurs on BLM lands where management plans also were revised recently (2008 and 2010) to adopt conservation measures identified in the LCAS. Implementation of these USFS and BLM plans likely precludes landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places. Additionally, because lynx habitats in this unit are naturally highly-fragmented and, in most places, support low landscape-level hare densities, relatively minor impacts, especially to hare and lynx winter foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historic or current number of resident lynx in this unit. As described in section 2.3.2.2 above, the historic record and recent research show that the GYA has supported resident lynx, but it is unclear whether the area consistently supported a persistent resident population over time or whether it naturally supported resident lynx only intermittently. Most historic and recent verified lynx records are from the southern portion of this unit in the Gros Ventre, Salt River, Wind River, and Wyoming mountain ranges in the Bridger-Teton National Forest. Eighteen lynx were reported to have been trapped from a small area in the Wyoming Range in 1971-72 (Squires and Laurion 2000, p. 338), but it is unknown whether any of those lynx were residents (and if so, how many) or if some or all of them were dispersers associated with the "explosion" (irruption) of lynx documented in several places in the contiguous U.S. in the early 1970s (McKelvey *et al.* 2000, pp. 235-242). However, two resident lynx, a male and a female, were trapped, radio-marked, and monitored in the Wyoming Range over several years beginning in 1996. The female produced four kittens in 1998 and two in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000 (Squires and Laurion 2000, p. 346; Squires *et al.* 2001, pp. 9, 26). The female's home range averaged 50 km^2 (19 mi^2) over the 3 years she was monitored, and the male's averaged 824 km^2 (318 mi^2) over five years (Squires *et al.* 2003, pp. 12-13). The male also made multiple long-distance exploratory movements (up to 728 km [452 mi], including multiple highway crossings) over 3 successive years (Squires *et al.* 2003, pp. 13-16; Squires and Oakleaf 2005, entire).

Other surveys also detected lynx in the southern portion of this unit from 1999-2009, with records most consistent in the Wyoming Range, Togwotee Pass, Union Pass, the Bondurant Corridor, and in the Gros Ventre Range (Squires *et al.* 2001, pp. 9-14; Squires *et al.* 2003, pp. 9-11, 29-31; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016 pers. comm.; Squires *in* Lynx SSA Team 2016, pp. 20-21). Additionally, 10 radio-marked lynx released in Colorado subsequently moved into or through this portion of the GYA unit from 2004-2010, with locations concentrated in areas used previously by native Wyoming lynx (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.). Several of the Colorado-released lynx occupied home ranges (including overlapping male and female home ranges) in areas of the Wyoming Range previously occupied by "native" resident lynx (Squires *in* Lynx SSA Team 2016, p. 21), but there is no evidence of reproduction among these lynx. On the Shoshone National Forest in the northeastern part of this unit, seven lynx snow tracks were confirmed by DNA analysis in winter 2005/06, and a single track was verified the following winter (Endeavor Wildlife Research 2008, p. 2; Berg 2016, pers. comm.). During the winters of 2004-05 through 2007-08, 26 snow tracks on the Bridger-Teton and Shoshone national forests were confirmed by DNA analyses to be from five individual lynx (3 males, 2 females). One of the males had previously been documented in Yellowstone National Park (see below). The other two males and both females were lynx that had been released in Colorado (Pilgrim 2016, pers. comm.).

Verified records of lynx are less common elsewhere in this unit, including in Yellowstone and Grand Teton national parks and the Custer-Gallatin National Forest. There were no verified records of lynx in Yellowstone National Park from 1920-1999 (McKelvey *et al.* 2000, p. 230); however, surveys in 2001-2004 documented at least 3 individual lynx, including two kittens, in

the eastern part of the park (Murphy *et al.* 2006, entire). Several Colorado-released lynx also traveled through the park (Devineau *et al.* 2010, p. 526), and two possible (unconfirmed) lynx tracks were recorded in the park during winter 2008/2009 (Endeavor Wildlife Research 2009, pp. 4, 12). On the Custer-Gallatin National Forest in Montana in the northern part of the unit, a single female was detected over six consecutive winters (2003/2004 - 2008/2009) but not subsequently (Gehman *et al.* 2010, pp. 2-4), and it appears that she did not encounter a male or produce kittens during the six years she was detected (Gehman *et al.* 2010, p. 4).

Recent surveys and research-related trapping efforts have failed to detect lynx in this unit after 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45; Hanvey 2016, pers. comm.). As discussed above and in section 2.3.2.2, it is uncertain whether this unit historically supported a small but persistent resident population that was recently extirpated, or if it historically and recently has supported resident lynx only intermittently. Given the protected conservation status of millions of acres in this unit, its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx (Lynx SSA Team 2016, p. 57). Conversely, the characteristics described above suggest that relatively small impacts could tip this unit from just barely able to support a persistent resident population to incapable of doing so. Further, the available evidence suggests that if this unit did support a persistent population, it was very likely a very small one, which would be more vulnerable to extirpation due to demographic, environmental, and genetic stochasticity, and to catastrophic events (McKelvey *et al.* 2000b, pp. 23-29), or to a combination of these factors.

Factors Affecting Current Conditions: *Regulatory Mechanisms* - As described above for Unit 3, federal management activities (e.g., timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on federal lands and impacts appear to have been localized, they were deemed a low-level to threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. Current regulatory mechanisms and conservation measures associated with recently amended or revised federal management plans are intended to conserve and restore lynx and hare habitats across large landscapes. Although their effectiveness has not been quantitatively evaluated, they have almost certainly reduced significantly the potential for adverse management-related impacts to lynx habitats in this unit.

Lynx trapping has been prohibited in Wyoming since 1973 (79 FR 54794) and in Montana since 1999 (MTFWP 2016, p. 7) and, as described in section 3.1.2, above, both states require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, no lynx are documented to have been incidentally trapped in the Montana portion of this unit (MTFWP 2016, pp. 5-10) and we are aware of no incidental captures in northwestern Wyoming since listing.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Mote *et al.* 2005, entire; Pederson *et al.* 2013; Riley *et al.* 2013; Dennison *et al.* 2014, entire; USEPA 2015, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities low in some places, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. However, modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609).

Vegetation Management - The influence of vegetation management on the current condition of lynx and habitats in this unit is described above under Habitat Status and *Regulatory Mechanisms*.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, likely in response to climate warming and related increases in drought conditions (e.g., Dennison *et al.* 2014, entire; Harvey *et al.* 2016, entire; Westerling 2016, entire), with most large, stand-replacing fires having occurred in the northern part of the unit, in Yellowstone National Park (see Harvey *et al.* 2016, Fig. 1). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to continue to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction on lands with

developmental allocations. Much of this unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental allocations. Even in areas with developmental allocations, the moist subalpine forests important to lynx have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx. Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Wyoming (1; a Colorado-released lynx) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates of are unknown. Although this unit is not directly connected to lynx habitats and populations in Canada or elsewhere in the contiguous U.S., no barriers to lynx dispersal from the north have been identified, and 10 lynx released in Colorado are known to have dispersed northward into and through this unit (Devineau *et al.* 2010, p. 526; Hanvey 2016, pers. comm.), demonstrating that dispersal between the southern and northern Rockies is possible. As described above in Lynx Status, the large number of lynx reportedly trapped from a small area of the Wyoming Range in the early 1970s (Squires and Laurion 2000, p. 338) may suggest dispersers associated with the irruption of many lynx from Canada into the northern contiguous U.S. documented at that time (McKelvey *et al.* 2000, pp. 235-242). No subsequent pulses of lynx dispersing from the north have been documented, and lynx trapping records suggest that the magnitude of lynx populations cycles in Alberta and British Columbia, the most likely source of lynx dispersing southward into this unit, dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

As described in section 3.2, above, a number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this geographic unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, it is possible that it has contributed to the recent apparent loss of resident lynx from this unit.

4.2.6 Unit 6 - Southern Rockies Geographic Area

Unit Description - The overall geographic unit includes Colorado, south-central Wyoming, and north-central New Mexico. However, within the southern Rockies, since we currently have no evidence of resident lynx in southern Wyoming or northern New Mexico, and we question the ability of these two areas to support breeding populations we are not including these two areas in the unit description. Lynx habitat in Colorado totals approximately 25,294 km^2 (9,766 mi^2), and is distributed west of US Interstate-25. We excluded the northwest part of the state bounded on the south by US Interstate-70 and the east by Colorado State Highway 13, because this area lacks sufficient habitat to support lynx. Lynx habitat in Colorado falls within the following land ownerships, USFS 21,555 km^2 (8,322 mi^2), BLM 772 km^2, (298 mi^2), NPS 452 km^2 (174 mi^2), Private 2,350 km^2 (907 mi^2), State 164 km^2 (63 mi^2).

The southern Rockies are separated from the rest of the Rocky Mountain chain, and thus lynx habitat in northern and western Wyoming, by sagebrush and desert shrub communities in the Wyoming Basin and the Red Desert of southern and central Wyoming, and the arid Green and Colorado River plateaus of western Colorado and eastern Utah. Connectivity of lynx habitat has been identified as an important consideration for the southern Rockies, because of the extreme topographic relief juxtaposed with human developments such as highways and residential communities.

Habitat Description - Lynx habitat in the southern Rockies is found within the subalpine and upper montane forest zones, generally above 2,900 m (9,514 ft) elevation (Shenk 2009 page 10). In the upper elevations of the subalpine zone, forests are typically dominated by subalpine fir and Engelmann spruce. As the subalpine zone transitions to the upper montane, spruce-fir forests begin to give way to lodgepole pine and aspen. On cooler, mesic mid-elevation sites, Engelmann spruce may retain dominance, intermixed with aspen, lodgepole pine, and Douglas-fir. Lodgepole pine reaches its southern limits in the central part of the geographic unit, while southwestern white fir occurs only in the San Juan Mountains. The lower montane zone is dominated by ponderosa pine and Douglas-fir, with pines typically dominating on lower, drier, more exposed sites, and Douglas-fir occurring on the more sheltered sites. Lower montane forests do not support snowshoe hares and seldom would be used by lynx.

Mature Engelmann spruce/subalpine fir forests with total canopy cover of 42–65 percent, of which 15–20 percent was contributed by conifer understory tree canopies, were the most commonly used areas, followed by mixed forests of Engelmann spruce/subalpine fir/aspen (Shenk 2008, page 15). Riparian and riparian-mix was the third most-used cover type, with a pattern of increasing use beginning in July, peaking in November, and dropping off in December. Large or medium willow/alder carrs and willow riparian communities provided important habitat for snowshoe hare, grouse, ptarmigan (winter), and other prey species that could be utilized by lynx.

Ivan *et al.* (2012 page 5) confirmed some relationships that were already known (e.g., lynx are strongly associated with high-elevation spruce/fir and mixed spruce/fir forests but avoid lower-

elevation montane forests and montane shrublands). We recognize that all spruce-fir forest does not support lynx equally based on the low detection rate (28 percent) reported during the ongoing lynx study in the San Juan Mountains within predominantly spruce-fir forest (Ivan, Workshop presentation 2015, p. 14), thus not all areas of spruce-fir forest are used by lynx.

Dolbeer and Clark (1975 page 539) estimated a density of 0.73 hares/ha (0.3 hares/ac) within their study site in Colorado, with the highest densities of snowshoe hare in mature and late-successional spruce-fir forests. However, this study was conducted in a very limited area and did not sample younger sapling-stage stands (15-40 years post-disturbance) to compare hare densities with those reported for mature and late-successional spruce-fir forests (USFWS 2008, p. 32).

Habitat that supports snowshoe hares is patchily distributed in the Southern Rocky Mountains Geographic Unit, which limits their abundance. Zahratka and Shenk (2008 entire) found densities of snowshoe hares to be greatest in mature Engelmann spruce-subalpine fir stands when compared to mature lodgepole pine stands in Taylor Park, Colorado. Their density estimates were 0.08±0.03 to 1.32±0.15 hares/ha (0.03–0.5 hares/ac) in Engelmann spruce-subalpine fir habitats, and 0.06±0.01 to 0.34±0.06 hares/ha (0.02–0.14 hares/ac) in lodgepole pine habitats (Zahratka and Shenk 2008 entire).

Ivan (2011*a in ILBT 2013*) compared snowshoe hare density, survival, and recruitment in mature uneven-aged spruce/fir stands, small-diameter lodgepole pine (2.54–12.7 cm [1–5 in]) stands (20–25 years old), and medium-diameter (12.7–22.9 cm [5–9 in]) previously-thinned lodgepole pine stands (40–60 years old) in Colorado. During summer, Ivan (2011*a* in *ILBT 2013*) recorded densities of 0.2+0.01 to 0.66+0.07 hares/ha (0.08–0.27 hares/ac) in small lodgepole pine forest, 0.01+0.04 to 0.03+0.03 hares/ha (0.004–0.01 hares/ac) in medium lodgepole forest, and 0.01±0.002 to 0.26±0.08 hares/ha (0.004–0.1 hares/ac) in spruce/fir forest; densities were more similar across the 3 forest types during the winter months. He concluded that “hares reached their highest densities and recruited juveniles most consistently in stands of small lodgepole, followed closely by spruce/fir, but survival was highest in spruce/fir stands.”

Habitat Status - At the time of the 2000 listing, we identified 26,305 km^2 (10,156 mi^2) of potential lynx habitat in the Southern Rockies (i.e., Colorado and southern Wyoming) [65 FR 16052). In 2003, we estimated 31,027 km^2 (12,419 mi^2) of potential habitat within the southern Rockies (68 FR 40076). As stated above, our focus here is limited to the state of Colorado. In 2008, the USFS reported that most of their LAUs in the southern Rockies fell within a range of 3-8 percent in a currently unsuitable condition, with only one LAU exceeding 30 percent unsuitable (USFS 2008, p. 19). Currently, the USFS reports 51 out of 202 (25%) LAUs currently exceed the 30 percent unsuitable condition (P. McDonald 2016, pers. comm.). These changes are mostly in response to the ongoing bark beetle infestations, as well as wildfire events that have occurred since 2008.

Ivan *et al.* (2012, p. 6), developed a predictive map of lynx habitat use by using lynx location data collected during CPWs reintroduction monitoring, then estimated the amount of habitat associated with a high probability of detecting lynx. Our review of the vegetative characteristics of CPW's predictive map detected large areas of spruce-fir habitats that were excluded by their presentation of the habitat associated the top 20 percent of predicted use. Therefore, we selected the top 30 percent of the Ivan *et al.* (2012, entire) predictions and the associated habitat to represent the amount of potential lynx habitat in Colorado totaling 25,294 km^2 (9,766 mi^2). This habitat estimate falls between the Ivan *et al.* (2012, p. 6) estimate and the USFS's habitat estimate of 30,664 km^2 [11,839 mi^2] (USFS 2008, p. 18), while retaining a greater than 60 percent probability of detecting lynx as described by Ivan *et al.* (2012).

Regulatory mechanisms in Colorado are largely provided through Forest Service planning documents. All USFS land management plans within the unit were amended in 2008 to provide for the conservation of lynx. Three BLM plans in Colorado have been amended or revised to conserve lynx following the 2013 LCAS, totaling approximately 126 km^2 (49 mi^2). One additional plan provides conservation measures for timber management actions only, but the FO contains only about 1 km^2 (0.39 mi^2). The remaining FOs currently have not amended or revised their plans specifically to provide conservation for lynx (approximately 645 km^2 (298 mi^2), Since the 2000 listing however, all BLM Field Offices in Colorado have been conserving lynx discretionarily through application of conservation measures provided in the Lynx Conservation Assessment and Strategy (Ruediger *et al.* 2000, entire; ILBT 2013, entire). Rocky Mountain National Park has a fire management plan that includes conservation measures for lynx. We are not aware of any specific conservation planning guiding activities on non-federal lands (M. Wrigley 2016, pers. comm. ; M.K. Watry 2016, pers. comm.).

Lynx Status - As of 2016, the current distribution of lynx is somewhat uncertain within Colorado. However, we believe it is reasonable that lynx continue to occupy all National Forests within the state of Colorado (Odell 2016, undocumented pers. comm.), and Rocky Mountain National Park (Shenk 2008, p. 3). The CPW is developing a minimally-invasive, long-term, statewide monitoring program to track the distribution, stability, and persistence of lynx in Colorado (Ivan 2012, entire).

As of 2015, evidence of recent lynx reproduction is provided through kittens captured on game cameras accompanying adult females at three locations during 2014-2015 monitoring effort (Ivan presentation 2015 page 17). In addition 38 percent of lynx captured during recent (2010-2015) USFS Rocky Mountain Research Station research projects in Colorado have been young and/or unmarked cats (Ivan *in* Lynx SSA Team 2016, p. 17), suggesting continued reproduction within Colorado. However, reproductive rates are currently unknown.

As of 2007, the average probability of survival for reintroduced lynx was 0.9315±0.0325 within the study area in the San Juan Mountains and 0.8219±0.0744 outside the study area boundary (Devineau *et al.* 2010, page 5). Although 30 percent of known mortalities were due to human causes (being shot or hit by a vehicle), the estimate of survival within the study area was higher than those reported for natural, lightly trapped populations of Canada lynx in the Yukon (0.75–

0.90; Slough and Mowat 1996 entire, O'Donoghue *et al.* 1997, page 155) or in the Northwest Territories (~0.90; Poole 1994, page 612). Successful reproduction, including by females born in Colorado, has been documented (Shenk 2008, page 2), and kitten survival was 0.2260 (Jake Ivan, pers comm. March 9, 2016).

Factors Affecting Current Conditions - Colorado is currently experiencing major bark beetle epidemics in lodgepole pine and spruce-fir forests. Although bark beetles are native insects, and forests in the western U.S. have experienced regular insect infestations throughout their history, the current bark beetle epidemic is notable for its intensity and extensive geographic range. The causes of this epidemic include: relatively even-aged, dense, and homogenous forest conditions, which are highly susceptible to beetle attack, and which were created by large-scale logging in the late 1800s and subsequent fire suppression efforts; warmer winters due to climate change (cold winters typically reduce beetle populations); and a multi-year drought that occurred in the mid-1990s through early 2000s, stressing the trees and making them more susceptible to beetle attack (USFS 2011, pp. 4).

In lodgepole pine forests, a mountain pine beetle (*Dendroctonus ponderosae*) epidemic typically kills the entire overstory and results in a stand-replacing disturbance event. In Colorado, more than 1,375,931 ha (3,400,000 ac) has been affected by mountain pine beetle, and 639,000 ha (1,579,000 acres) affected by spruce beetle since 1996 (USFS 2015, p. 3), a portion of which overlaps with lynx habitat.

Even-aged mature and "dry" lodgepole pine stands characteristically have depauperate understory vegetation and are not capable of supporting dense populations of snowshoe hares. On moist sites, regeneration of beetle-killed lodgepole pine stands is expected to be relatively rapid 20-30 years, and the new stands will be dominated by resprouting aspen or by a new cohort of lodgepole pine. If these newly-established stands grow tall and dense enough to provide horizontal cover above the snow layer, they may produce excellent habitat for snowshoe hares and lynx for several decades, until the crowns again lift above the reach of snowshoe hares.

A spruce beetle epidemic kills the larger-diameter trees and can also result in a stand-replacing disturbance event. Because of the importance of spruce-fir forests for production and survival of snowshoe hares (Ivan 2011a in ILBT 2013), widespread mortality of mature spruce/fir forests could impact lynx habitat for a long duration. By 2015, the spruce beetle outbreak influenced approximately 95 percent of the mature spruce component of the subalpine cover types on the Rio Grande National Forest (Squires *et al.* unpublished report 2016, page 1). Despite the large scale, and almost complete mortality of the mature spruce component within their study area, lynx continue to use and reproduce in the beetle-infested forests (Squires *et al.* unpublished report 2016, page 2). Since the majority of lynx habitat in Colorado is under federal land management (88 Percent), actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. However, habitat connectivity may be negatively affected by intense recreational use or development within strategic areas that are important for habitat connectivity.

ILBT (2013 p. 57; 61-62) states:

> *Plague, a flea-borne disease caused by the bacterium Yersinia pestis, which is not native to North America, was reported for the first time in lynx in Colorado (Wild et al. 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 reintroduced lynx between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to Y. pestis; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado.*
>
> *Vehicular collisions are a potentially important cause of mortality for lynx in portions of the southern Rockies. Thirteen of 102 mortalities documented for lynx translocated into Colorado were from vehicle collisions (Devineau et al. 2010). Brocke et al. (1990) suggested that translocated animals might be more vulnerable to highway mortality than resident lynx and this could have been a factor in Colorado at the time of listing. Currently, the majority of lynx mortalities caused by vehicle collision (13 of 16) occurred during the reintroduction period (1999-2006). Since early 2007, one year after the final reintroductions occurred, only 3 hit by vehicle mortalities have been reported, and only two of those occurred in Colorado (Broderdorp unpublished data 2016). A number of highways with high speed and high traffic volume pass through lynx habitat, such as I-70, I-80, US 50, US 550 and US 160. These highways are not a barrier to lynx movement, as repeated successful crossings by radio-telemetered lynx have been documented on I-70 and Highways 9, 40, 50, 91, and 114 (Ivan 2011b, c, 2012; J. Squires, personal communication 2012). At this time, it appears that hit by vehicle mortality may be a less significant mortality factor for lynx in Colorado.*
>
> *As compared with other portions of the range of lynx, in Colorado more winter recreation and associated development overlaps with lynx habitat. Preliminary information from a study in Colorado indicates that some winter recreation uses may be compatible, but lynx may avoid some developed ski areas (J. Squires, personal communication 2012). It is possible that ski areas and 4-season resorts may reduce the amount and availability of lynx habitat within localized areas, in part by influencing the distribution or abundance of prey resources within the developed area. However, there is also considerable anecdotal evidence of lynx using ski areas.*
>
> *Leg-hold trapping is currently prohibited under the state constitution of Colorado as a means of predator control or for commercial and recreational trapping. If a landowner can prove that all other non-lethal methods have been ineffective, a 30-day exemption may be granted for depredation cases. Incidental trapping mortality of lynx may be a minor risk during trapping seasons in southern Wyoming and surrounding states.*
>
> *Predator control activities on federal lands, including coyote shooting or trapping, are common throughout most of this geographic area, mostly related to the grazing of domestic sheep. The majority of sheep grazing occurs on arid rangelands, but some*

grazing does occur during summer at the higher elevations, especially in south-central Colorado. Incidental capture of lynx is possible, but unlikely.

Chapter 5: Future Conditions

In this chapter, we present our assessment, based on the best available scientific information, ncluding the professional judgment and opinions of lynx experts, of the ~~potential~~ future ~~status~~condition of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the likely future conditions in each geographic unit, followed by a more detailed evaluation of the factors likely to influence lynx populations and habitats in each unit. We present and summarize the professional judgments and opinions of a panel of 10 lynx experts regarding the factors likely to influence the persistence of resident lynx populations in the DPS as a whole and in each of the ~~six~~6 geographic units. We also present and summarize the experts' projections, based on consideration of those influencing factors, of the probability that each of the geographic units will continue to support resident breeding populations of lynx into the future (at years 2025, 2050, and 2100). We then provide additional Service review of the influencing factors described in Chapter 3, above, and their potential effects on the ability of each geographic unit to support lynx populations in the future.

5.1 Summary of Future Conditions DPS-wide

Given the irresolvable uncertainty about the historical distribution of resident lynx in the contiguous U.S. and the current lack of reliable estimates of the sizes, trends, and many demographic parameters for most DPS populations, it is difficult to confidently predict the future ~~status~~condition of the DPS or the likelihood that any given geographic unit will support resident lynx in the future. We lack data to build rigorous empirical population models for lynx in the DPS, and uncertainty regarding the timing and magnitude of potential impacts to lynx from continued climate warming also limits our ability to predict the future condition~~s for~~of the DPS. Therefore, our assessment of the future condition of the DPS is based on the best professional judgments and opinions of lynx experts and our evaluation of the available scientific information regarding the factors identified by the ILBT as the most likely to have population-level impact to lynx in the DPS (ILBT 2013, pp. 68-78).

Overall, expert opinion and our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). This outcome seems likely

Comment [MJM31]: We need to explain the context for this analysis of future conditions. This context includes the absence of ESA listing and the protections it provides (no section 9 prohibitions, no section 7 consultation, etc.). This context is important to avoid the circular outcome that ESA listing is unwarranted because the species is sufficiently protected from threats due to its listing under the ESA.

Was this context explained to the experts who provided input?

Comment [MJM32]: This assessment of future condi ions focuses on the "likely" outcome of he threats acting on the species. This focus on only the likely outcome is essentially a single future scenario analysis. Our SSA Guidance directs us to look at a range of future scenarios so as to capture he full risk to the species. A risk analysis requires an assessment of the full range of plausible futures and their probabilities. Even when a "good" future for the species is likely, lower likelihood "bad" future scenarios can individually or cumulatively cons itute sufficient risk to the species to warrant listing.

Comment [MJM33]: This sounds like we consider expert opinion as constituting the best available science/information. Opinions, by hemselves, can never constitute best available information. We should never simply refer to expert opinion as the basis of our conclusions. We must draw our own independent conclusions. Our conclusions can be informed by expert opinion, but we must explain the reasons the experts hold their opinions, explain why we agree or disagree with this reasoning, and then arrive at our own conclusions (making it clear that these are our conclusions). We can hen say "Based on the best available ...

Comment [MJM34]: Use "future condition" or "population status" to avoid confusion with lis ing status (E/T).

Comment [MJM35]: This is an example of where we incorrectly refer to expert opinion as something we consider "in addition to" he best available science. We can consider ONLY the best available science. Our understanding/analysis of the best available science is informed by expert opinion.

Comment [MJM36]: We need to also consider the risks posed by factors that may be of a lower likelihood but still meaningful.

Comment [MJM37]: This paragraph seems to be describing "our" overall conclusions. But it's confusing when it refers to the experts' opinions. We don't need to refer to the experts' opinions when we are presenting our conclusions. We should clearly establish in the introduction to his sec ion where our conclusions come from.

Comment [MJM38]: We need to also consider the risk posed by the less-than-likely probability that he sizes and distributions of populations will be reduced even more.

regardless of which climate emissions scenario is used to model future conditions, although the timing, extent, and magnitude of impacts is uncertain and will likely vary by scenario.

In addition to climate change, forest management also has the potential to influence (negatively or positively) hare and lynx habitats in the DPS range. Forest management on private lands that lack lynx conservation commitments may contribute to future declines in the amount and quality of lynx habitats, particularly in Maine and perhaps also in Minnesota (private lands contribute minimally to lynx habitats in the other geographic units – see ~~T~~table 1, above). Uncertain future forest ownership and markets for forest products, shifts in silvicultural practices, and development pressures on private lands all may affect the resiliency of future lynx populations and thus the units. The lack of evaluation of the effectiveness of forest management plans for lynx on ~~f~~Federal lands is of concern for western units.

In each geographic unit, the probability that resident lynx populations will persist is expected to decline in the future, although uncertainty about persistence probability increases with time from the present (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below). Although all five geographic units that currently support resident populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century. All other geographic units have a 50-percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below), with a moderate to high likelihood that resident lynx will be lost from two to four units by then (~~F~~figure 7).

Comment [MJM39]: I don't understand what his is saying. Is it trying to say the probability of persistence declines as we look further out into the future? If so, this is a meaningless statement because it could be said of every species on earth. We need to convey the magnitude of the decline.

Comment [MJM40]: What do we expect?

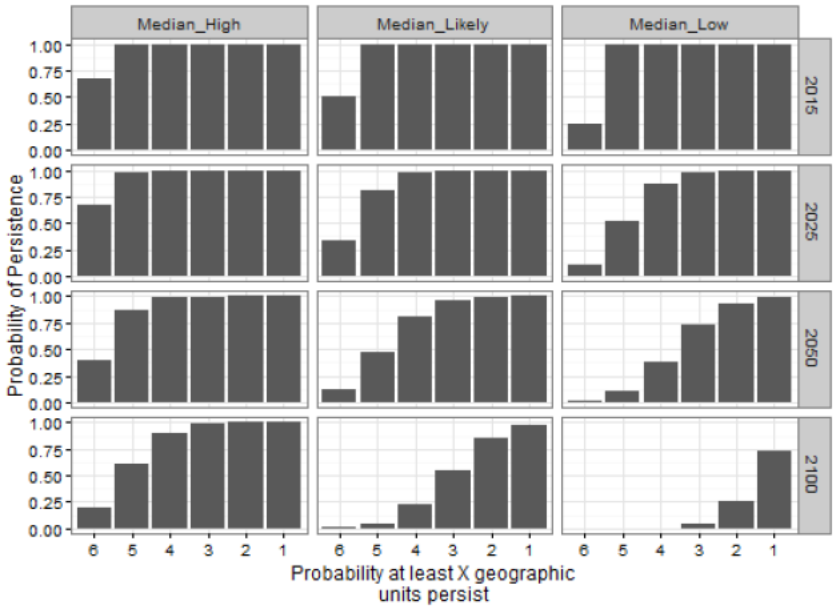


Figure 7. Summarized probability of persistence of at least a given number of geographic units given the probability of persistence for each individual geographic unit. The y axis of each grid in ~~F~~figure 7 is the probability that at least the number of geographic units indicated by the x axis of the grid persist. The probability in a bar reaches 1 when there is no probability of fewer geographic units persisting. Moving from top to bottom the grids show the probabilities by time period (2015, 2025, 2050, and 2100). Moving from left to right the grids show the range of expert responses by summary selection type and probability response. Therefore, looking down a column of grids provides a view of the trend in persistence through time and looking across a row of grids provides a view of the range of uncertainty in persistence for a given time period.

The loss of all resident lynx from one or more geographic units would represent reduced future redundancy, representation, and resiliency within the lynx DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (e.g., additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is

Comment [MJM41]: The title of the figure and he text should make clear that this is a summary of expert opinions.

Presenting the experts' opinions as line graphs and bar graphs makes it seem as if we are treating these opinions as data – as the best available science. They are only opinions. These opinions can inform our conclusions about how we interpret the science, but only after we have analyzed the reasoning behind hem.

Comment [MJM42]: This better portrays that we are drawing our own conclusions. Using the word "input" rather than "opinions" is a better way to get across the idea that it is the reasoning behind the opinions that matters. "Input" seems to capture both the opinions and he reasoning behind them.

Comment [MJM43]: What about climate change? Shouldn't we qualify his as we do below for the statement about extirpation of the whole DPS?

Comment [MJM44]: Recommend stating his as a probability. "Could" means "possible." I suspect the intended meaning is that it's highly unlikely, not that it's impossible.

Comment [MJM45]: But we didn't say how likely the first claim is that this claim is being compared to.

Comment [MJM46]: What is he likelihood of such a series of events? This statement has no benefit to the analysis without stating the likelihood.

Comment [MJM47]: Of what? A geographic unit or the whole DPS?

uncertain, there seems to be little risk of significant genetic drift. This is because of the currently- observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and likely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Based on expert input, there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS.

How the potential loss of resident lynx from one or more geographic units may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

In terms of resiliency, expert opinion and our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

5.1.1 Summaries of Future Conditions in Each Geographic I Unit

Unit 1 – Northern Maine: Although the Northern Maine geographic unit currently has extensive lynx habitat, it may be one of the units in the DPS at greater risk. Forestry practices and climate change will be the greatest future drivers of hare and lynx habitat. Lynx habitat and numbers are expected to decline by 50 to 60 percent by 2032 in response to aging of the budworm-era clearcuts and the effects of 27 years of extensive partial harvesting. In the next few decades,

Comment [MJM48]: But what is he likelihood hat the level of gene flow will not be high? To say there is little risk of genetic drift, we need to be able to say the likelihood is very low hat gene flow will be reduced to a level that would cause his problem. It's apparent that the likelihood is something less than likely, but "less han likely" is not necessarily "very low."

Comment [MJM49]: This better portrays that we are drawing our own conclusions. Using the word "input" rather than "opinions" is a better way to get across the idea that it is the reasoning behind the opinions that matters. "Input" seems to capture both the opinions and he reasoning behind them.

Comment [MJM50]: Again, we don't need to keep referring to expert opinion when presenting "our" conclusions.

Comment [MJM51]: This is a meaningless statement. We need to describe the magnitude of this decline in probability.

high quality hare habitat will drop from about 10 percent to 5 percent of the landscape. High quality habitat patches will become more fragmented, smaller, and more isolated, thus making the landscape less suitable for lynx. For the next few decades the best habitat will occur in the southern portion of the range where effects of climate change and competition with bobcats are likely to be greatest. Absent long-term lynx management agreements, the future of lynx habitat is uncertain. Wood products markets will continue to change, and could be affected by interest in carbon sequestration in response to climate change. Rapid changes in private forest land ownership are likely to continue resulting in subdivision of large ownerships. Changing land uses (wind energy development, transmission line corridors, residential land development, national monument) will compete with forest management as the primary land use. Conservation easements will help reduce development pressures and keep some lands as working forest. Climate change is expected to affect the Maine unit more than others in the DPS because snow depth and duration already seem to be at thresholds for lynx and there are few potential elevational refugia. In the near term and to mid-century, snow quantity and quality will continue to deteriorate, likely causing the range of lynx to begin contracting northward. In the long term (to 2100), some believe lynx could become extirpated from the unit. Climate change, increasing demand for hardwood forest products, a pending spruce-budworm outbreak, and frequent disturbance of the forest all will contribute toward the trend in the loss of spruce-fir forest and expansion of northern hardwoods, although the timeframe for conversion is uncertain. Lynx experts indicate the probability of persistence will decline to about 50% by the end of the century. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, lack of elevational refugia), some members of the Service's SSA team were more pessimistic about the future of lynx in Maine than the lynx expert panel. There is great uncertainty about the future of forest management and future development on private forest lands. There are no long-term management plans in place, State forest regulations have greatly influenced harvesting practices that have (and will continue to) reduce landscape hare densities, markets for forest products are depressed, and projections (under current harvest scenarios) are that habitat will diminish and shift southward in the near term because of post-harvest succession and recede northward over the longer-term because of continued climate warming.

Comment [MJM52]: This is exactly what we need to do with all he experts' opinions – explain why we agree or disagree. Where is his analysis?

Unit 2 - Northeastern Minnesota: The direct and indirect effects of climate change are expected to affect lynx into the future in Minnesota. Specifically, there is an expected decline in the quantity, quality, and duration of snow; increased competition and hybridization with bobcats; northward contraction of boreal conifer forest; and increased isolation due to diminishing forest conditions in Ontario. The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century, driven in the near term by the quality, quantity and persistence of snow, competition, disease, and forest insects, and over the long term from the some of the same reasons with the addition of climate change, loss of spruce-fir forests, and wildfires. If the SNF in Minnesota continues to follow vegetation management and other recommendations under the LCAS in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue on State and private

lands. Taking all factors into consideration (i.e., loss of boreal forest, increased competition, potential disease and insect outbreaks, loss of snow), lynx experts projected the mean probability persistence of lynx in Minnesota to the year 2025 was greater than 90 percent, to 2050 was 80 percent, and would decline to approximately 35 percent by 2100.

Comment [MJM53]: What do WE project and why?

Unit 3 - Northwestern Montana/Northeastern Idaho: As in other units, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Fire- and insect-related habitat losses would likely be temporary, resulting subsequently in improved habitat conditions when impacted areas regenerate the dense vegetative structure conducive to hare abundance. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Lynx experts felt that future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Considering the factors above, lynx experts felt this geographic unit has the highest likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence > 0.95), at mid-century (median = 0.90), and end-of-century (median = 0.78), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units.

Comment [MJM54]: What do WE conclude?

Comment [MJM55]: What do WE conclude and why?

Unit 4 - North-central Washington: Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within north Cascades, which has significantly affected the status of and current viability of the lynx population within this geographic unit. Similar to the other geographic units, climate change is anticipated to reduce the future quality and distribution of lynx habitat in Washington, potentially further exacerbating the recent temporary losses of lynx habitat from wildfires. Climate change may increase wildfire frequency and severity, which may result in further temporary losses of lynx habitat. Climate change may also decrease the quantity and quality of snow resulting in permanent reductions in the quantity and distribution of lynx habitat in Washington State. These potential climate change driven reductions of lynx habitat may serve to further isolate lynx populations within Washington State as well as between neighboring lynx populations in the other geographic units and Canada. Continued forest management on both federal and State lands will benefit lynx populations in Washington, but this may not completely ameliorate the potential negative effects related to climate change. Considering the recent reduction in lynx habitat and the projected impacts of climate change, experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), mid-century persistence at 30% to 80% (median = 70%), and end-of century (year 2100) persistence probabilities less than 50% (median = 38%) for lynx populations within this geographic unit.

Comment [MJM56]: What do WE predict and why?

Unit 5 - Greater Yellowstone Area (GYA): As elsewhere, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Because potential habitats in much of this unit already are naturally highly fragmented and perhaps only marginally capable of supporting resident lynx, and because it appears to have never supported more than a small number of residents, its ability to do so in the future is tenuous. Lynx experts felt that the small number of lynx this unit appears capable of supporting and its relative isolation from other lynx populations make it more vulnerable to genetic drift and extirpation due to catastrophic events or demographic or environmental stochasticity. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Considering the factors above, lynx experts felt this geographic unit has the lowest likelihood of supporting resident lynx into the future in the near term (year 2025; median probability of persistence = 0.52), at mid-century (median = 0.35), and end-of-century (median = 0.15), with a declining probability of persistence and greater uncertainty with increasing time from present, as in all units.

Unit 6 - Western Colorado: Climate change is expected to affect vegetation and influence snow conditions within the Western Colorado unit. The elevation gradient in Colorado may provide refugia from deteriorating snow quality, depth, and duration throughout the period. Climate models suggest a 40 percent decline in snow persistence, but large areas of snow persistence will remain through the end of the century. Experts suggest that beetle kill and fire will result in unsuitable habitat conditions. However, these areas are likely to regenerate and provide excellent habitat conditions to support hares and lynx. A caveat to future habitat conditions in light of climate warming is that some areas that currently support snowshoe hare populations may experience vegetation type conversion that may not support snowshoe hares. The majority of the experts predicted the persistence of a viable lynx population in the unit by 2100, but further discussion revealed uncertainty about persistence in the unit, and genetic connectivity across ski areas in the unit.

Table 4, below, summarizes factors thought likely to influence the future resiliency of lynx populations in each geographic unit.

Table 4. Predicted ~~F~~future (2050 to 2100) resiliency of individual units of the Canada lynx DPS

Lynx population	Lynx expert probability of	Key evidence	Uncertainties

Comment [MJM57]: What do WE conclude and why?

Comment [MJM58]: What do WE conclude and why?

Comment [MJM59]: Is this our thought or the experts'?

Comment [MJM60]: To he point of retracting he prediction? Need to explain he magnitude of the uncertainty.

Comment [MJM61]: By whom? The experts or us? The ti le of the table needs to make this clear.

Comment [MJM62]: See above comment. Need to make it clear if this represents our hinking or the experts' hinking.

	persistence		
Unit 1 Maine	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	• 50% decline in habitat expected by 2032, habitat will occur in south edge of range • Slight recovery of habitat by end of century depending on forestry trends • Continued demographic and genetic connectivity to southern Quebec, New Brunswick populations • Climate models predict deteriorating snow quality, depth and duration below thresholds for lynx; more severe than other units • Little elevation refugia	• Future forest management trends and habitat conditions on private forest lands in Maine and Canada • Future shifts in land ownership, forest products markets, and development • Extent and pace of deteriorating snow conditions • Response of hares (pelage mismatch), bobcat and fisher to changing snow regime • Extent and pace of loss of spruce-fir • Future trends in hare populations • Disease and parasites in lynx • Effects of lynx trapping in Quebec
Unit 2 Minnesota	2050 median 80% (range 35 to 100%) 2100 median 35% (range 0 to 100%)	• Smaller population could be susceptible to stochastic effects • Habitat conditions on national forests will remain stable or improve if managed for softwoods • Continued demographic and genetic connectivity to southern Ontario populations • Climate models predict deteriorating snow quality, depth and duration below thresholds for lynx • Little elevation gradient: lake-effect snow may retain refugia to 2050 but not 2100	• Future forest management trends and habitat conditions on private forest lands in Minnesota and Ontario • Extent and pace of deteriorating snow conditions • Response of bobcat and fisher to changing snow regime • Rate of decline of spruce-fir • Future trends in hare populations • Disease and parasites in lynx
Unit 3 Northwestern Montana	2050 median 90% (range 40 to 100%) 2100 median ~78% (range 10 to 100%)	• Some habitat loss from increased wildfire, otherwise habitat will remain stable with USFS management • Continued demographic and genetic connectivity to southern British Columbia populations • Potential high elevation buffer against climate change • Recent loss of small sub-metapopulation in Garnet Range • Increasing fire frequency	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks • Extent and pace of deteriorating snow conditions • Response of bobcat, pumas, coyotes to changing snow regime • Extent and pace of elevational migration of spruce-fir • Mismatch in elevation between appropriate snow regime for lynx and spruce-fir • Future trends in hare populations
Unit 4 North-central Washington	2050 median 70% (range 10 to 100%)	• Habitat and population low because of recent fires; could be susceptible to stochastic effects • Continued demographic and genetic	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks

	2100 median ~38% (range 0 to 90%)	connectivity to southern British Columbia populations ● Elevation is not sufficient to provide long-term refugia from deteriorating snow quality, depth, and dura ion	● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations
Unit 5 Greater Yellowstone	2050 median 35% (range 0 to 90%) 2100 median 15% (range 0 to 90%)	● Habitat loss from 1980s wildfire, otherwise habitat will remain stable with USFS and NPS management ● No connectivity with Canada populations; little immigration from DPS populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Low quality habitat; dry; low hare populations ● Smaller population could be susceptible to stochastic effects	● Will habitat support adequate landscape hare densities to support lynx? ● Extent to which GYA remains demographically isolated from other DPS populations; immigration from Colorado population ● Extent and frequency of insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Future trends in hare populations ● Extent to which high elevation may provide climate and snow refugia ● Extent to which area will be repopulated by the north and/or the south
Unit 6 Western Colorado	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	● Habitat loss from increased wildfire and insect outbreaks, otherwise habitat will remain stable with USFS management ● Isolation from other lynx populations ● Elevation may provide refugia from deteriorating snow quality, depth and duration ● Uncertainty about stability of recently-reintroduced lynx population	● Demographic and genetic effects of isolated population ● Extent and frequency of fire in hare-lynx habitat ● Extent and frequency of future insect outbreaks ● Extent and pace of deteriorating snow conditions ● Response of bobcat, pumas, coyotes to changing snow regime ● Extent and pace of elevational migration of spruce-fir ● Mismatch in elevation between appropriate snow regime for lynx and spruce-fir ● Future trends in hare populations

5.2 Future Conditions - Detailed Descriptions by Geographic Unit

5.2.1 Unit 1 - Northern Maine

Expert Projections of Future Lynx Status

Most experts indicated an initially high and subsequently declining probability of persistence of resident lynx in Maine through the end of the century, with uncertainty (range between lowest and highest probabilities) also increasing over time (Lynx SSA Team 2016, pp. 33-36 and Fig. XX below). Climate change was an overriding near- and long-term stressor.

Increased winter precipitation in the form of rain, reduced snow depth, and reduced snow durations were discussed. Changes in snow conditions will favor bobcats and fisher (a predator of lynx that is limited by deep snow). Experts believed that the effects of climate change would continue to increase as a stressor by mid- to the end of the century (2050, 2100). Snow conditions would continue to deteriorate (especially in the northern Maine unit compared to other areas in the DPS) resulting in increased competition with bobcats and predation by fisher. Climate-induced loss of spruce-fir forest will occur slowly, and an increase in northern hardwood composition of the forest is already occurring. Loss of spruce-fir could be accelerated by forest disturbance (budworm outbreak, forest management affecting large acreages of lynx habitat annually).

Experts expressed a number of near-term stressors (in the next 15 years) related to forest management in northern Maine. Land management objectives were uncertain because of changes in private forest land ownership. Changes in forestry management because of the Maine Forest Practices Act (shift to partial harvesting, increasing acreage harvest, habitat shifting to south) would result in increased fragmentation and declining lynx and snowshoe hare habitat (succession of previous clearcuts from young, dense regenerating stands to mature stands less conducive to high hare densities).

There was uncertainty concerning the severity and response by new landowners to the next spruce budworm outbreak. Experts were concerned that investment landowners would not respond to the pending spruce budworm outbreak like they did in the 1970s (extensive clearcuts, herbicide application). Experts also acknowledged concerns about the effects of the current clearcuts aging past conditions that support hares and lynx.

Hare populations have declined by about half across all stand types (and in adjacent Quebec) since 2006 and apparently have not rebounded. In response, lynx initially had lower reproduction (lower proportion of females breeding, slightly lower litter sizes), but this has not affected home range sizes. Lower landscape hare densities are likely to support lower lynx populations. It is uncertain how hare numbers will cycle or fluctuate in the future.

Comment [MJM63]: See earlier comment. Need to explain what we think about he experts' opinions and heir rationale and draw our own conclusions – and own those conclusions. Where do we do this?

Comment [MJM64]: To avoid confusion with lis ing status (i.e., E/T), refer to "population status" or "persistence."

Comment [MJM65]: Didn't hey all indicate his? Can't this be said of every species on earth?

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of spruce-fir, and bobcat competition are likely to reduce the probability of lynx persistence in this unit. Modeling of current lynx habitat and future habitat trends was more advanced for the Northern Maine Unit than other units. Models indicate that aging of past clearcuts and changes in forest practices to partial harvesting will diminish the current lynx habitat by half in coming decades. Experts and the core team expressed uncertainty about the severity of a pending spruce budworm outbreak, forestry response by investment company landowners, and how this will affect future lynx habitat. More is known about long-term trends in snowshoe hare populations in this unit than others. Hares seem to have declined by half since about 2006 and have remained low. Experts and the core team were uncertain about whether hare numbers would rebound or remain at this lower level, but lower hare densities are affecting demographics (especially percentage of females breeding), which could contribute to population declines. Taking all of these factors into consideration, the experts projected the mean probability of persistence to the years 2025 was greater than 95 percent, to 2050 was about 80 percent (range from 20 to 100 percent), and to 2100 was about 50 percent (range from 0 to 100%)(Lynx SSA Team 2016, pp. 33-34, Fig. 8). The USFWS lynx core team generally agreed with this prognosis with the exception that some were less optimistic about the persistence of this population, especially after reviewing the literature pertaining to climate change in this region.

Comment [MJM66]: These ranges encompass the full range of responses. For the other units, hese ranges encompass just he "most likely" points. Why the difference for the Maine unit?

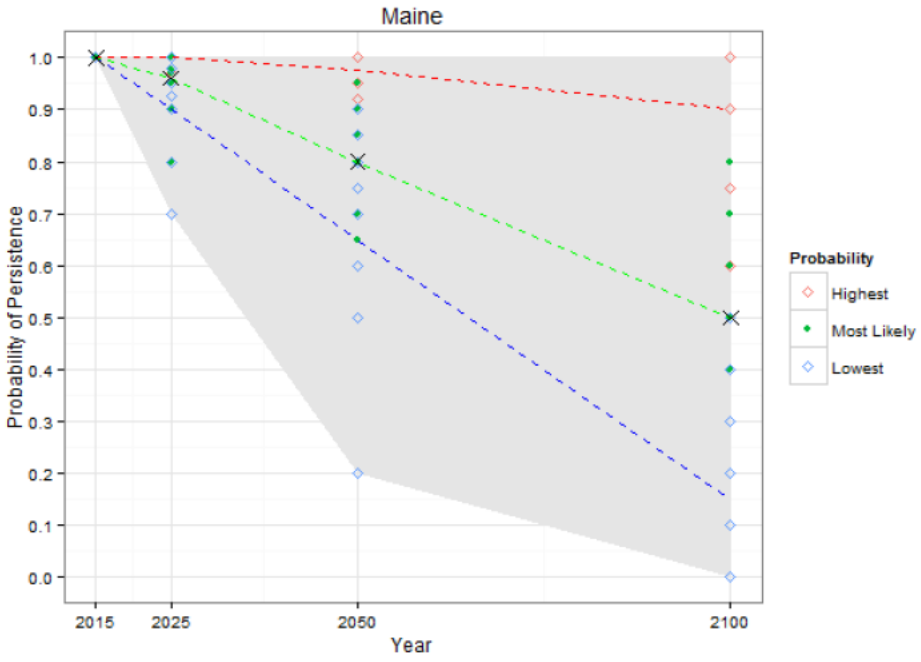


Figure 8. Lynx expert estimates of the probability that the Northern Maine Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Note: In Figure 8, above, and similar figures for the other geographic units, below, points for each of the 10 expert responses, for each of the three probability-of-persistence levels, i.e., highest, most likely, and lowest probabilities of persistence, are represented by the hollow red, filled green, and hollow blue points respectively. The black x mark is the median of the most likely responses across the experts in each response year. The red, green, and blue dashed lines connect the median of the highest, most likely, and lowest probability of persistence responses across the experts in each response year. The edges of the grey area were defined by the extreme responses, i.e., the range from the largest of the highest probability of persistence responses to the smallest of the lowest probability of persistence responses. The median lines and grey area are provided as a summarizing visualization to aid comprehension of the experts' responses and their range, and should not be viewed as a substitute for individual responses or presented outside the context of the accompanying discussion.

Service Evaluation of Factors Influencing Future Conditions

Comment [MJM67]: Where do we explain whether we agree or disagree with the experts' opinions and why? The "Service evaluation" for each unit seems to be independent of he discussions about the preceding "Expert Projections" for each unit I was expecting this explanation to be in he Service evaluations.

Regulatory Mechanisms - In response to public concern about widespread clearcutting in northern Maine, in 1989 the Maine Legislature passed the Maine Forest Practices Act (MFPA). The MFPA regulates maximum size of clearcuts (250 acres), separation zones between clearcuts, harvest plans, and notification to the Maine Forest Service. Clearcuts are not banned, but require varying levels of state permits depending on their size. As a result, the number and acreage of clearcuts completed annually has declined substantially and have been replaced by various forms of partial harvesting (Sader *et al.* 2003, p. 349-350, McWilliams *et al.* 2003, p. 35). In the first decade following passage of the MFPA, the percentage of acreage clearcut in Maine annually declined from 40 percent to 4 percent (Simons 2009, pp. 45-46). The average size of clearcuts has been reduced from >125 acres (Maine Forest Service 1995) to <25 acres (Maine Forest Service 2003, 2005, 2007). Currently, partial harvesting comprises about 94 percent of acres cut annually in Maine (Simons 2009, p. 50). The total volume harvested, however, changed relatively little. The partial harvest that replaced clearcuts include a variety of silvicultural treatments, including both even-aged (e.g., shelterwood) and uneven-aged (e.g., selection) management that result in a wide range of residual stand conditions (Robinson 2006), which have important implications for lynx conservation. Foremost, snowshoe hare densities in partially harvested forests are on average about 50 percent lower (but range from 20 to 90 percent lower) than in regenerating conifer stands created by clearcutting (Robinson 2006, entire; Scott 2009, p. 109, Simons 2009 p. 83), thus reducing landscape hare density and presenting a challenge for future lynx conservation (Simons 2009, pp. 206, 209, 217; Simons-Legaard *et al.* 2016, p. 7-8; Simons-Legaard 2016, entire).

To harvest the same volume of wood annually, landowners must partial harvest many more acres than they would under former clearcutting silvicultural systems. The acres of forest harvested annually in Maine have increased from about 250,000 acres pre-MFPA to 550,000 acres post-MFPA (McWilliams *et al.* 2003, p. 35). Currently, 27 years after implementing the

MFPA, much of the 10 million-acre northern Maine landscape has been influenced by partial harvesting. Extensive partial harvesting and aging of the spruce budworm-era clearcuts will reduce landscape hare densities (Simons-Legaard *et al.* 2016, 9-10). If the current landowners continue to harvest using similar methods at and similar rates, habitat for lynx will diminish by about 50 percent by 2030 (Simons-Legaard 2016, pp. 9-10). After 2030, projected outcomes for lynx habitat become more uncertain and depend on assumptions about habitat definitions and harvest rates. Lynx in Maine selected for regenerating, conifer-dominated forest (>75 percent conifer, Vashon *et al.* 2008, pp. 1490, 1492-1494). If one defines lynx habitat as stands having greater than 75 percent spruce-fir, then habitat will decline by about 50 percent by 2030 and remain at about at this level through 2060 (Simons-Legaard 2016, pp. 9,16).

These projections do not consider the next outbreak of spruce budworm. After being low for the last 20 years, spruce budworm numbers are again building toward epidemic levels in Maine, southern Quebec, and northern New Brunswick. Significant defoliation in Maine is expected to begin between 2018 and 2021 (Wagner *et al.* 2014). Although Maine research has clearly demonstrated that landowner response to the last outbreak resulted in unintended, positive benefits for lynx from one to three decades later, our ability to project what effects the next outbreak will have on lynx habitat is still limited. Land ownership has changed dramatically since the last outbreak. To reduce risk from spruce budworm, some financial investment owners may cut younger spruce-fir stands that still support elevated hare populations. Some may be less inclined to intensively manage for spruce-fir. It is unlikely that current landowners will use widespread use of pesticides to control spruce budworm and herbicides to promote spruce-fir regeneration after stands are defoliated. The MFPA may serve as an additional constraint on motivation to clearcut infested stands, even with recently-enacted changes intended to reduce the regulatory burden for landowners. Landowner response to the pending outbreak will have important implications for the short- and long-term persistence of lynx habitat in the northern Maine unit (Simons-Legaard 2016, pp. 16-17).

Nor do these projections consider a substantial decline in snowshoe hare densities that has occurred in Maine. Snowshoe hare density declined by 69.3 percent from a period of high hare density in 2001-2006 (average of 2.1 hares/ha in regenerating conifer) to a period of lower hare density 2007-2009 (average of 1.0 hares/ha). This decline occurred across all forest stand types and across a broad geographic area of Maine (Scott 2009 p. 36) and the adjacent Gaspe region of southern Quebec (Assells *et al.* 2007, Scott 2009, p. 41-42). Hares remained at these lower numbers through 2013 (D. Harrison, University of Maine, unpublished data). If future hare populations remain low, then Maine habitats will have a lower capacity for supporting lynx.

Climate Change - The northern Maine unit is more vulnerable to snowpack loss because of the lack of elevational refugia (Siren *in* Lynx SSA Team 2016, pp. 15 and experts p. 37) and changes in snow conditions could further restrict their range (Hoving 2002, Hoving *et al.* 2005, Carroll 2007). Wildlife experts in Maine ranked lynx as highly vulnerable to climate change (>66 percent loss in species range/population and extirpation within 50 to 100 years) (Whitman *et al.* 2013, p. 19, 74). Similarly, Carroll (2007, entire) modeled Maine lynx population assuming non-cycling hare populations and snow conditions expected under intermediate to high emissions

Comment [MJM68]: Lynx in Maine, or lynx everywhere?

climate models (Kiehl and Gent 2004, entire). He predicted a 59 percent decline in the lynx population (the non-cycling hare population model) by mid-century because of climate change alone. Maine lacks elevational refugia for lynx under reduced snow scenarios (Carroll 2007, p. 1102), except for the mountains in western Maine where snow refugia may only persist as very small, isolated “sky islands” that would be unlikely to support lynx.

Climate change is affecting the Northeast, and the rate of change is faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the reduced persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46^{o} C/decade with the greatest warming occurring in the coldest months of winter (January, February)(Burakowski *et al.* 2008). Northeast climate models predict average winter temperature increasing 2.0^{o}C (low emission) to 2.9^{o}C (high emission) by mid-century and 3.1^{o}C (low emissions) to 5.3^{o}C (high emissions) by late century (Notaro *et al.* 2014). Largest increases in temperature are expected in northern Maine (A. Siren, Workshop Notes 2016, Rawlins *et al.* 2012) where temperatures may increase 4.5 to 5.0^{o} F by 2050 (Fernandez *et al.* 2015, p. 3). In response to climate change, interest in wind development has escalated in northern and western Maine increasing threats to high elevation and potential spruce-fir refugia (Whitman *et al.* 2013). Climate conditions are currently at or falling below threshold values needed to support lynx in Maine.

If future trends in increasing temperature and decreasing snow occur, then lynx are unlikely to persist in Maine. Gonzales *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007) and predicted loss of forest and snow conditions able to support lynx in Maine by the end of the century. Although there are uncertainties about future climate warming, lynx populations in Maine are expected to recede northward and decline substantially this century (Vashon *et al.* (2012, p. 60).

Snow Duration. The current average snow duration in Maine is at or below the 4-month snow persistence thresholds believed needed to support lynx (section 4.1.1, Gonzales *et al.* 2007) and is projected to decline. Snow duration is projected to continue to deteriorate. Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another ~~two~~2 weeks in Maine by mid-century (Fernandez *et al.* 2015). Snow duration is expected to diminish by 25 percent (low emissions) to 50 percent (high emissions) from current conditions by the end of the century (Hayhoe *et al.* 2006). Similarly, Notaro *et al.* (2014) projected an average decrease of 28 days (low emission) to 47 days of snow cover (high emissions) by the end of the century.

Snow Depth. The current average snow depth in northern Maine is at or below the 270 cm/yr. (106 in/yr) thresholds believed needed to support lynx (section 4.1.1; Hoving *et al.* 2005) and is expected to decline. By the end of the century, large areas of the Northeast will experience 15-percent (low emission) to 25-percent (high emissions) reduced snowfall (Ning and Bradley 2015). Similarly, by the end of the century Notaro *et al.* (2014) projected average snow declines in the North Atlantic Landscape Conservation Cooperative of 59 cm (31 percent) (low

emissions) to 92 cm (48 percent) (high emissions) because a higher proportion of winter precipitation will fall in the form of rain rather than snow. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015).

Snow Quality. Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, Hayhoe *et al.* 2007, Ning and Bradley 2015). Snow density and compaction (caused by wet, heavy snow or rain on snow events in winter) will continue to increase in the region in the future (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006, Karl *et al.* 1993).

Loss of Boreal Forest. Climate change is projected to cause a northward contraction of spruce-fir forest in the Northeast with potential negative consequences for both lynx and snowshoe hares (Gonzales *et al.* 2007, entire). Spruce-fir forest is expected to decline substantially in Maine and the Northeast (Ollinger *et al.* 2007 Beckage *et al.* 2008, Tang and Beckage 2010, Whitman *et al.* 2010, p. 12, Jacobson *et al.* 2009, p. 27) or disappear (Iverson and Prasad 2001, pp. 192-193, Prasad *et al.* 2007) because of climate change. Climate change is anticipated to increasingly fragment the boreal forest in northern New England (Iverson *et al.* 2008, Ollinger *et al.* 2008, Whitman *et al.* 2013). Lynx habitat will decline as boreal forest diminishes (Simons 2009). Even under the lowest emissions scenarios, spruce-fir forest would be greatly reduced by 2100 (Williams and Liebhold 1997, Prasad *et al.* 2007), although some spruce-fir may persist at highest elevations (Tang and Beckage 2010) and along the eastern coast (Jacobson *et al.* 2009) where cooler conditions will prevail.

The spruce-fir forest type has come and gone from New England during the post-glacial period. It nearly disappeared from the Northeast during interglacial warming period 1000 years ago, then moved south into New England only in the past few centuries during the “Little Ice Age” (Schauffler and Jacobson 2002, DeHayes *et al.* 2000). Because of its sensitivity to climate and mobile nature, Iverson *et al.* (2008, p. 403) predicted a significant decline (low emissions) or the disappearance (high emissions) of the spruce-fir forest type in northern Maine in response to climate change.

Spruce (red, black, white) and balsam fir are the most important boreal forest conifer tree species in the Northeast and will be affected by climate change in different ways. Mechanisms of injury to spruce-fir include winter injury from freeze-thaw cycles, spring drought (because of reduced snowpack), and reduced seed germination (Perfect *et al.* 1987, Auclair *et al.* 2010). Thus, the range of spruce-fir is limited by summer heat and drought. Mohan *et al.* 2009 projected that suitable area for balsam fir would decline by 80 percent in 2100 under an average to high emissions scenario. In contrast, Ollinger *et al.* (2008) projected increasing growth rates for balsam fir and red spruce to mid-century, after which they would decline.

The timescale of the spruce-fir decline in the Northeast is difficult to predict because of the many variables that influence shifting of the forest species composition (emissions scenarios, the long lifespan of trees, slowness of tree dispersal, frequency of disturbance, competition from advancing hardwoods and invasive tree species, complex interactions with moisture, and synergistic effects with other pollutants). Arguments in favor of an accelerated decline include evidence that spruce-fir is already in decline (Seymour 1992, Simons 2009) and is being replaced in Maine by northern hardwoods (oak, pine, red maple). The decline of the spruce-fir forest type is accelerated by forest disturbances. A pending spruce budworm outbreak and frequent disturbance from forest management could accelerate conversion to northern hardwoods in northern Maine and eastern Canada (Flannigan *et al.* 2001, Gauthier *et al.* 2015). Other climate-related forest disturbances (forest pests, diseases) could further accelerate conversion to northern hardwoods (Iverson *et al.* 2008, p. 404).

In contrast, some authors note that trees migrate slowly and are long-lived. Therefore, a time lag may occur in shifting forest composition from spruce-fir to northern hardwoods (Mohan *et al.* 2009, Zhu *et al.* 2012). Some northern Maine industrial forest landowners could "adapt" to climate change by intentionally favoring spruce-fir (e.g., by plantations and use of herbicides). McWilliams *et al.* 2005 (p. 8) noted that balsam fir increased in Maine's forest inventory in the 2000s. Forest models projected increases in spruce-fir biomass over the next century because of partial harvesting and periodic budworm outbreaks, but did not take climate change into consideration (Simons-Legaard *et al.* 2013).

Finally, there is uncertainty concerning the influence of climate change on balsam fir, a short-lived, shade-tolerant, conifer that dominates much of the understory in the Acadian forest and is an important component of lynx habitat in the Northern Maine Unit. Climate change will influence precipitation and temperature, forest management strategies, and forest disturbance (fire frequency and spruce budworm), all of which will interact in complex ways to influence the spruce-fir forest at the southern edge of its range. Carter (1996), Iverson *et al.* (1999), and Goldblum and Rigg (2005) documented balsam fir growth rates and growth potential would decline under likely climate warming scenarios (~4 to 5 F degree temperature increase by the end of the century and reduced snow conditions). Some have projected the extirpation of spruce-fir forest types in the Great Lakes States (Scheller and Mladenoff 2005) and New England (Iverson and Prasad 2000). In contrast, balsam fir has prolific seed production following forest disturbance such as harvesting (Seymour 1992), and has proliferated under the current climate and forest management regime dominated by partial harvesting (Olson *et al.* 2013, entire). Balsam fir is a relatively short-lived tree (~100 years), and is unlikely to persist long if climate change affects seed and germinations rates. Given, anticipated climate changes, especially early snow melt and low spring precipitation, fir may increase for the next few decades but is unlikely to regenerate in a the future Maine forest (E. Simons-Legaard, University of Maine, pers. comm. May 31, 2015).

Vegetation Management - Habitat suitable for lynx is expected to decline in the future (see Regulatory Mechanisms section above). By 2020, all of the extensive areas that were clearcut in the 1970s and 1980s will be greater than 35 years of age and no longer support high hare

densities. For the foreseeable future, partial harvesting will continue as the primary means of forest management. Although partially harvested forests with well-developed understory structure may provide foraging opportunities via increased prey access (Fuller *et al.* 2007), snowshoe hare densities are approximately 50 percent less in landscapes dominated by partially harvested stands (Robinson 2006, entire; Fuller and Harrison 2010). Thus changing forest management practices will continue to reduce landscape hare density below levels that can support lynx.

Sources of uncertainty concerning future habitat conditions in northern Maine include changes in forest policy, timber harvesting methods, changing timberland ownership, response to budworm outbreaks, and timber markets - all of which have occurred in the recent past and will undoubtedly shape forest management in the future (Simons-Legaard *et al.* 2016, p. 8). Currently, the landscape is owned primarily by financial investors who may be less inclined to intensively manage for spruce and fir after the next outbreak of the spruce budworm (Wagner *et al.* 2014).

The dramatic shift from clearcutting to partial harvesting presents a challenge for lynx conservation in this unit for the next several decades. Lynx, habitat is expected to peak and remain stable through about 2020 (Simons 2009, Simons-Legaard *et al.* 2016 p. 6). After 2020, aging of the former clearcuts and extensive partial harvesting are projected to result in a 50 to 65 percent decline in lynx habitat by 2032. Lynx habitat will decline from about 9.5 percent of the landscape (current condition) to about 4.5 percent of the landscape (Simons-Legaard 2016). By 2032, the Northern Maine Unit may support less than half the lynx population as it does today (Simons 2009, p. 209, 217).

In the future, lynx habitat will be fragmented into smaller, isolated parcels, and will shift southward into areas occupied by bobcats and fishers where snow conditions are unlikely to support lynx (Simons 2009, Simons-Legaard *et al.* 2016, Simons-Legaard 2016). By 2022, the number of patches of high quality hare habitat will increase by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6). The proximity index of high quality habitat patches will decline by 78 percent within lynx home ranges. Although lynx habitat is peaking, fragmentation is diminishing its ability to support lynx (Simons-Legaard *et al.* 2016).

Beyond 2030 assumptions concerning future climate change, land ownership, and harvest rates introduce greater uncertainty. The most optimistic forest management models (greatest harvest rates, no climate change, no spruce budworm) project that lynx habitat will decline over the next few decades then gradually increase to about 10 percent of the landscape by 2060. The most most pessimistic models (lowest harvest rates, no climate change, no spruce budworm) project about 5 percent of northern Maine will have high quality hare habitat (Simons-Legaard 2016, entire), although the habitat will be much more fragmented and smaller patch size (Simons-Legaard *et al.* 2016).

Softwood plantations could offset losses in spruce-fir and become a form of adaptation to climate change. Jack pine plantations are extensive in adjacent New Brunswick (Etheridge *et al.* 2005, p. 1966). A forest company that has planted extensive spruce plantations in New Brunswick and recently purchased nearly 1 million acres of forestland in northern Maine where they are doing the same. Spruce plantations are becoming more common on this ownership in Maine, but not others. Stand structure and intensive management of plantations are highly variable (e.g., pruning, thinning, herbicide treatments), thus hare density and use by lynx vary (Roy *et al.*) Hares can achieved higher densities in plantations depending on the amount of lateral cover, but for shorter periods of time; ~10 to 17 years after cutting and planting in New Brunswick (Parker 1984, p. 163) and 15 to 25 years in Quebec (Roy *et al.* 2010, p. 585). This is in contrast to ~15 to 35 years in naturally regenerating spruce-fir stands after harvest (Simons-Legaard *et al.* 2016, p. 4). The future of plantations in the northern Maine unit is uncertain. Most investment landowners have short-term investment horizons and are unlikely to invest in plantations.

Natural stand-replacing disturbances are rare and infrequent and, other than spruce budworm outbreaks, are unlikely to significantly affect future habitat conditions (Hoving *et al.* 2004). A spruce budworm outbreak is projected to reach epidemic proportions in 2018 to 2021. The epidemic has already affected 10 million acres of spruce-fir in southern Quebec, immediately north of Maine (Wagner *et al.* 2014, entire). The last outbreak in the 1970s and 1980s killed millions of acres of spruce and fir forests in the northern Maine unit. Maine's 5.8 million acres of spruce-fir stands across the state are at risk of some level of defoliation. The intensity of the next outbreak is uncertain, although some project a weaker outbreak because spruce and fir trees are younger and less susceptible and there is a higher hardwood component in northern Maine forests (Wagner *et al.* 2014, p. 21-27). A typical outbreak lasts for a decade.

Forest management strategies for addressing the coming outbreak vary and include applying insecticides (although land area sprayed is expected to be small compared to the previous outbreak), pre-emptive cutting of mature spruce-fir before defoliation, stop precommercial and commercial thinning, and salvaging dead and diseased trees (Wagner *et al.* 2014, pp. 5-6). An aggressive forest management response (or not) will greatly affect future outcomes for lynx habitat (see section 5.2.1). The next budworm outbreak and subsequent forestry response is a disturbance agent that may accelerate changes in forest composition influenced by climate change, especially toward increased northern hardwood and reduced spruce-fir. The nature of landownership is greatly changed from the 1970s and 1980s, and landowner response is expected to be diverse depending on their objectives and investment horizons. The pending budworm outbreak cast additional uncertainty on the status of lynx habitat beyond 2030.

Climate change, forest management and budworm outbreaks will interact to influence the future trajectory of spruce-fir forest in Maine. All three variables have yet to be modeled simultaneously (K. Legaard, UMaine, personal communication). Assuming current forest management trends persist to the end of the century, spruce-fir dominated forest is expected to continue to decline (Legaard *et al.* 2013, entire). The combination of budworm-induced mortality and salvage harvesting will have a negative effect on spruce-fir (Legaard *et al.* 2013, entire).

However, after a budworm outbreak the biomass and area of mixed-hardwood/softwood forest would be expected to increase through this century primarily because of regenerating balsam fir (see discussion above) (Legaard *et al.* 2013). Mixed forests having a high hardwood component are not believed to support high hare densities (Scott 2009, p. 109) or be preferred by lynx (Vashon *et al.* 2008, pp. 1492-1493). It is uncertain whether lynx can adapt to lower landscape hare densities associated with mixed hardwood-softwood forest. They may persist, but at lower densities as they currently do in the western units of the DPS. However, the probability of persistence is further diminished by deteriorating snow conditions and increased populations of bobcats and other competitors.

Fire Management - Susceptibility of the northern Maine unit to fire may be enhanced by a severe spruce budworm outbreak because of the amount of dead and dying spruce-fir (Stocks 1987), although there were no large fires after the last outbreak. Fire risk is currently very low in this unit and a continuous decrease in fire frequency is predicted with climate change in eastern Canada because of increased precipitation and decreased drought (Bergeron and Flannigan 1995, Flannigan *et al.* 1998). Climate is expected to become more variable during the next century (Gregory & Mitchell 1995; Gregory *et al.* 1997), which could create fire conditions in unusually dry years (Flannigan *et al.* 1998, p. 475). Maine's policy is to immediately suppress wildfire, thus large, stand-replacing fires are expected to be infrequent in this region. Notable large fires in Maine include a 3 million-acre fire in 1825 and a 200,000-acre fire in 1947.

Habitat Fragmentation - The future of the 10 million-acre, sparsely populated "North Woods" of Maine is highly uncertain and has been the subject of intense public debate (Baldwin *et al.* 2007). Land use and zoning in the state's "unorganized townships" are the responsibility of the Land Use Planning Commission (LUPC) in the Maine Department of Conservation. The LUPC revised its Comprehensive Land Use Plan (De2010), and described principal values in guiding future land management decisions: maintaining working forests, provide for traditional recreational opportunities, protect high-value natural resources, and encourage long-term conservation. The North Woods has long been considered a public resource or "commons," even though privately owned (Judd 2007, p. 9). This land was traditionally owned by a few large timber companies, but since the 1980s there has been rapid turnover in ownership largely by investments companies and subdivision of large parcels (Hagan *et al.* 2005). Financial investors, such as REITS and TIMOs focus on maximizing the asset value of timberlands and are increasingly likely to seek revenue from non-timber resources if they will generate a higher return. These new owners operate over relatively short time horizons (e.g., 5 to 15 years) and are willing to consider multiple means of monetizing their asset, including development and real estate sales (Legaard 2013, entire). If left unchecked, these pressures may continue to promote dispersed residential development throughout this region. Parcelization and subdivision has increased, particularly in the southern third of the jurisdiction (Maine Department of Conservation 2010, p. 72-73). The LUPC has limited ability to address stressors on Maine's North Woods, including resale and subdivision trend. This trend is likely to continue into the foreseeable future and will make management of large, forested landscapes for Canada lynx even more difficult.

Historically, development has stayed mostly on the edges of the North Woods jurisdiction with exception of scattered seasonal dwellings and sporting camps in the interior, but this could change in the future. Between 1971 and 2005, the LUPC permitted 8,136 new dwellings in unorganized townships — an increase of 66 percent in the number of residences during this time period (Maine Department of Conservation 2010, p.80). Between 1971 and 2005, the LUPC issued 1,353 development permits for new uses scattered throughout the unorganized townships (Maine Department of Conservation 2010, pp. 97-99); most (42 percent) being recreational facilities (boat launches, campsites, gatehouses, recreational lodges). Most development has occurred in areas that abut organized communities and near public roads. Within the interior most development has occurred on long lakeshores and waterfront. However, the amount of hillside and ridge development is growing and this trend is likely to continue (Maine Department of Conservation 2010, p. 136), which will further fragment lynx habitat.

We have an incomplete understanding of the effects of outdoor recreation on lynx and their habitat (ILBT 2013, p. 80). Future trends in outdoor recreation in northern Maine are also uncertain (Vail 2007, entire). A portion of the North Maine Woods is a gated road system that encompasses about 3.5 million acres. Visitation by outdoor recreationists is currently about 175,000 per year and declining. Likewise, visitors to Baxter State Park and the Allagash Wilderness Waterway have declined (Vail 2007, p. 107). Aside from a vigorous discussion of a proposed national park or monument, national heritage area, or a master tourism plan for the area (Vail 2007, pp. 112-113), there is likely to be stagnant or declining participation in traditional outdoor recreational activities in the future (Vail 2007, p. 107). Snowmobiling may be an exception because of declining snow (see climate change section). The effects of new or expanded downhill ski development on fragmentation of lynx habitat are expected to be minimal. Three alpine ski resorts occur within the unit on the southern margin of lynx habitat: Saddleback Mountain Ski Area in Sandy River Plantation near Rangeley, Sugarloaf Mountain Ski Area in Carrabassett Valley, and Sunday River Skiway in Newry and Riley Township. Further development of ski areas is unlikely in the western Maine mountains. Future trends in outdoor recreation and associated effects on lynx, hares, and their habitat are uncertain in the northern Maine unit

Within the last ~~five~~5 years, two landowners developed concept plans for rezoning for large-scale development hundreds of house lots and resort development within the lynx critical habitat. One concept plan would construct 975 houses and ~~two~~2 resorts on about 3,500 acres and establish a 363,000-acre conservation easement. A second concept plan would allow development on about 1900 acres of land and establish a 14,600-~~-~~acre conservation easement. Although these developments have not been built, they may portend future trends in land use.

Energy production is emerging as a potentially significant economic factor in this unit, with grid-scale industrial wind power, biomass, biofuels, and other energy sources offering new opportunities to utilize natural resources. Wind energy resources are high within the lynx critical habitat (National Renewable Energy Laboratory 2010, http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mecitation; last accessed 5/25/2016), and wind development in the lynx critical habitat are likely to

accelerate in the foreseeable future. Mining is not a traditional land use, but a large operation is being considered at one location in the lynx critical habitat. Extraction operations for gravel (for road building) are widely scattered throughout the unit.

The lynx critical habitat is heavily roaded, particularly with forestry roads. While accurate numbers are difficult to obtain, approximately 1,500 miles of public roads and over 20,000 miles of private roads exist within unorganized areas of Maine (Maine Department of Conservation 2010). There has been discussion of an east-west limited access highway through northern Maine and extending Interstate 95 north from Houlton to Presque Isle, which, if constructed, would further fragment habitat (Maine Department of Transportation 1999, Beck *et al.* 2012, p. 38).

An increasing area of the lynx critical habitat area is likely to be placed under conservation easements that will limit future development and fragmentation of lynx habitat. Maine has the largest amount of land under easement of any state, and there are about 2 million acres of conservation easements in lynx habitat in northern Maine (Pidot 2011). Continued expansion of areas under conservation easement is uncertain and will depend on willing landowners and funding available for purchase of easements

All of development trends portend increased fragmentation of lynx habitat in the northern Maine unit. As habitat is fragmented, it will become increasingly difficult to influence landscape-scale forest management that could benefit lynx.

5.2.2 Unit 2 - Northeastern Minnesota

Expert Projections of Lynx Status

The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century (Lynx SSA Team 2016, pp. 37-38 and Figure 9, below). Near term drivers of the projected decline were reduced quality, quantity, and persistence of snow, competition from bobcats, disease (*e.g.*, lungworm, liver fluke, feline leukemia), and forest insects. Long term drivers of the projected decline were reduced the quality, quantity, and persistence of snow, competition from bobcats, loss of spruce-fir forests, wildfires, and climate change. Climate change was primarily associated with loss of boreal forest but could potentially also increase disease or insect outbreaks, and is likely to affect the amount of precipitation falling as good quality snow in the area of the state supporting lynx habitat. The connection to lynx in Ontario reduces the likelihood of local extirpation in this geographic unit, but the likelihood would increase if connectivity was compromised. Taking all factors into consideration (i.e., loss of boreal forest, competitions, disease and insect outbreaks, loss of snow), the experts projected the mean probability persistence to the year 2025 was greater than 90 percent, to 2050 was 80 percent (ranging from 60 to 90 percent), and would decline to approximately 35 percent (ranging from 10 to 60 percent) by 2100 (Lynx SSA Team 2016, pp. 37- 38).

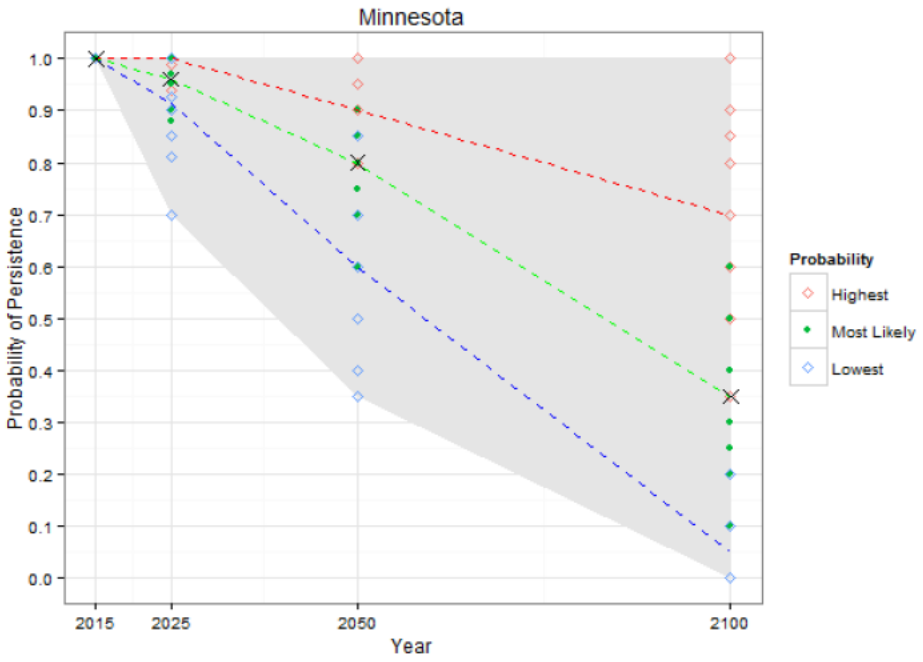


Figure 9. Lynx expert estimates of the probability that the Northeastern Minnesota Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - In Minnesota, the vast majority of lynx habitat that supports long-term persistent lynx breeding population is administered by the Superior National Forest. This area includes designated critical habitat (79 FR 54782). The SNF is currently implementing the 2004 SNF Plan (USDA 2004a), which has direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the Superior National Forest has a long-term commitment for doing so. If the SNF continues to follow vegetation and wildland fire management and other applicable recommendations under the 2000 LCAS (or the updated 2013 LCAS or subsequent updates) in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. Management of lynx and its habitat on SNF land will remain in place until the forest amends or revises ~~their~~its individual LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended Forest Plans (LPMPs).

Comment [MJM69]: See comments about establishing proper context (lynx not listed) for evalua ing future conditions.

Although outside of areas considered to be core lynx area (i.e., where lynx are persistent and are reproducing) in the Great Lakes, the Chippewa National Forest and the Chequamegon-Nicolet National Forest Forest Plans also include direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (LCAS 2000, entire), for all forest activities that occur within LAUs (USDA CNF 2004, USDA CNNF 2004).

Additionally, the Minnesota Department of Natural Resources (MN DNR) manages approximately 36 percent of the lynx habitat in this unit, and private landowners make up about 16 percent of the unit. Under the Sustainable Forest Resource Act of 1995 (revised in 2014), the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2013, entire; MFRC 2014, entire) - these voluntary guidelines are intended for private and state landowners and include some general recommendations for wildlife including lynx (MFRC 2014, pp. 4-5). It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue. Private landowners, however, do not have an official commitment to land management. We cannot say with any certainty what proportion of privately owned land will follow those guidelines into the future, because following the guidelines is voluntary.

Comment [MJM70]: But two sentences before we say we expect voluntary ac ions will continue. This makes it sound like we have no clue whether anyone will follow the guidelines. Surely we can say with some certainty that at least some minimal number of landowners will continue to follow he guidelines.

The NPS manages Voyageurs National Park, which is also within the Minnesota unit. Voyageurs National Park protects an area of 882 km^2, of which 534 km^2 (62 percent) is covered by forests and other uplands (Moen *et al.* 2012, p. 348), but does not have lynx specific direction in its management plan (NPS 2002, entire). The National Park consults with the FWS to consider the effects of any projects to lynx (NPS 2002, p. 26) and is anticipated to do so as long as the species is listed under the ESA. Lynx documented on and near Voyageurs National Park are probably transient animals (Moen *et al.* 2012, p. 348).

Approximately 1 percent of the Minnesota unit is managed by the Grand Portage Band of Chippewa, who has been actively working on lynx conservation since 2004. On-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire) and are expected to continue into the future.

In response to a 2008 court ruling, the MN DNR began to draft a plan to address incidental take of lynx that may result from otherwise legal trapping in Minnesota. This plan is still under development by the MN DNR and will be designed to reduce the likelihood of incidental take from trapping (LCAS 2013, p. 49).

Comment [MJM71]: But what do we think will happen if lynx were not listed?

Climate Change - The direct and indirect effects of climate warming are expected to affect lynx in Minnesota (Siren *in* Lynx SSA Team 2016, pp. 15 and Moen *in* Lynx SSA Team 2016, p. 19) and could further restrict their range. Since the time of listing, new information on regional climate changes and potential effects to lynx habitat has been developed (e.g., Danby & Hik 2007; Gonzalez *et al.* 2007; Knowles *et al.* 2006, Notaro *et al.* 2015), and this new information

suggests that climate change may be an issue of concern for the future conservation of lynx because lynx distribution and habitat is likely to shift upward in elevation within its currently occupied range as temperatures increase (Gonzalez *et al.* 2007, entire). Greatest stressors of climate change include diminishing snow depth, quality and duration; competition from bobcats and other carnivores, hybridization with bobcat (Schwartz *et al.* 2002); loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing forest conditions in Ontario.

Gonzales *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007, pp. 44-47) and predicted loss of forest and snow conditions able to support lynx in Minnesota by the end of the century. Notaro *et al.* (2015, pp. 1668-1669) projected changes in lake effect snowfall using downscaled climate models (Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4; Elguindi *et al.* 2011 and Giorgi *et al.* 2012 as cited in Notaro *et al.* 2015) for the Great Lakes Basin. Siren (*in* Lynx SSA Team 2016, p. 15) stated that climate models show an increase in lake effect snow in the eastern Great Lakes until 2050, with a decline later in the century, with an overall decline in the amount and duration of pack in the Midwest. Although there are uncertainties about future climate warming, lynx populations in Minnesota are expected to recede northward and decline over the next century (Lynx SSA Team 2016, pp. 37-38).

Lynx require at least ~~four~~4 months (120 days) of continuous snow coverage (Gonzales *et al.* 2007, p. 7). Snow cover days of 1 inch or greater in northern Minnesota (1959 -1979) ranged from 130-160 days, of 6 inches or greater ranged from 85 to 130 days, of 12 inches or greater ranged from 50 to 100 days, of 24 inches or greater ranged from 10 to 30 days (Kuehnast *et al.* 1982, pp. 7-9). In the future, Notaro *et al.* (2015, p. 1675) projected a general reduction in the frequency of heavy lake-effect snowstorms during the twenty-first century, with the exception of projected mid-century increases around Lake Superior when local air temperatures are expected to remain low enough for precipitation to largely fall in the form of snow. The snow season in the Great Lakes basin is likely to become substantially compressed during the twenty-first century with dramatic increases in rainfall (Notaro *et al.* 2015, pp. 1676-1678). The Minnesota unit may be more vulnerable to snowpack loss due to lack of elevational refugia (Siren *in* Lynx SSA Team 2016, p. 15).

Normal annual snowfall from 1981-2010 in northeastern Minnesota ranged from 140 to 241 cm per year (55 to 95 in/yr.) http://www.dnr.state.mn.us/climate/summaries_and_publications/normals_snow_1981_2010.html, accessed 24May2016) and is projected to decline across the Great Lakes Basin (Notaro *et al.* 2015, p. 1675). Snow quality ('fluffiness") is projected to deteriorate in the Great Lakes. Notaro *et al.* (2015, pp. 1671-1674) projected a dramatic decline of Great Lakes ice cover that will become confined to the northern shallow lakeshores during mid-to-late winter by the end of the century. Ultimately, this leads to increased rainfall, not snowfall, as these projected reductions in ice cover and greater dynamically induced wind fetch lead to enhanced lake evaporation and total lake-effect precipitation (Notaro *et al.* 2015, pp. 1674-1678).

Climate change is projected to cause some northward contraction of boreal conifer forest in Minnesota (Gonzales *et al.* 2007, p. 16, 18) with some potential loss of habitat at the southern portion of lynx habitat in the state (Gonzales *et al.* p. 2007, p. 19). According to Frelich (*in* Lynx SSA 2016, p. 14) Minnesota is likely to lose boreal biome, potentially within the next 60 to 70 years, with unmitigated climate change. According to Gonzales *et al.* (2007, p. 8), the Superior National Forest is a potential refugia for lynx in the lower 48 states, however, when compared to other regions.

Vegetation Management - Vegetation management conducted under the Forest Plan currently will likely continue into the future on Forest Service lands in Minnesota. These activities include timber harvest, such as thinning, clear-cutting, shelterwood, partial cut, and uneven-aged cutting; wildlife restoration projects that involve tree cutting, shearing, burning, seeding, and planting; prescribed burning for ecological purposes, hazardous fuel reduction, and site preparation; mechanical site preparation.

Vegetation, timber, and minerals management authorized under the Forest Plan has the potential to adversely affect lynx and lynx critical habitat by reducing habitat quality for denning, foraging, and dispersal; disrupting travel, resting, and foraging patterns; disturbing denning females and reducing habitat quality for lynx prey species, especially snowshoe hare. Depending on the timing, frequency, intensity, extent, amount, or other conditions, impacts may be variable among similar projects. Using the LCAS as a basis, the Forest Plan has incorporated a number of components that would reduce the risk of those impacts into the future. We expect that management direction for lynx addressing vegetation management on national forest system lands will be incorporated into the revised or amended future plans, using LCAS as a basis.

Future Forest Plan revisions will likely maintain broad direction to design and implement vegetation management projects to maintain or restore conditions for lynx foraging and denning habitat and to maintain or improve juxtaposition of required habitat types and connectivity.

Over the long term, the Forest Plan will alter vegetation patterns on the landscape. Suitable hare habitat was predicted to decrease over time with implementation of the Forest Plan, but has actually increased since 2004 (USFWS 2011, p. 51). Management activities that create unsuitable conditions for hare generally include clear-cut and seed tree harvest, and might include management-ignited fire, mechanical site preparation, salvage harvest, and shelterwood and commercially-thinned harvest, depending on unit size and remaining stand composition and structure. Suitable hare habitat is predicted to remain above the range of natural variation, which is essentially a description of conditions that existed prior to European settlement (1600 – 1900 A.D.) of the area (USDA 2004b, p. 105). Further, unsuitable habitat for lynx would vary only slightly with continued implementation of the Forest Plan and would remain distinctly below the maximum of 15 percent unsuitable in a decade prescribed in the LCAS and incorporated into the Forest Plan. Current (2010) unsuitable habitat levels are below what was predicted in the 2004 (USFWS 2011, pp. 51-52). Because suitable habitat on National Forest lands alone is

such a high percentage within LAUs and the Superior National Forest is the majority landowner within most LAUs, we expect that in the future, the Forest would not approach the LCAS maximum of 30 percent of lynx habitat on all ownerships in an unsuitable condition within an LAU at any time, which would be ensured by corresponding guidance in the Forest Plan.

Wildland Fire Management - Unlike the Maine unit, the susceptibility of the Minnesota unit to fire may be reduced by periodic spruce budworm outbreaks. Measurable defoliation due to spruce budworm has occurred in Northeastern Minnesota continuously since 1954 (MN DNR http://www.dnr.state.mn.us/fid/july2014/articles.html) and is expected to continue into the future. Modeling to evaluate the relative strength of interactions between spruce budworm outbreaks and fire disturbances in the BWCA showed that budworm disturbance can partially mitigate long-term future fire risk by periodically reducing live ladder fuel within the forest types of the BWCA but will do little to reverse the compositional trends caused in part by reduced fire rotations there (Sturtevant *et al.* 2012, pp. 1286-1292).

The Superior National Forest manages for wildfires through preventative measures such as fuels reductions, but does not manage for wildfires in the BWCAW. Natural successional changes and those associated with natural phenomena, such as wildfire or windstorms, are and are expected to continue to be the dominant force in ecosystems on the BWCAW.

Habitat Fragmentation - Ravenscroft *et al.* (2010, p. 329) considers northeastern Minnesota forest landscape as largely un-fragmented. The BWCAW remains intact and contiguous with Canada. Within the SNF, natural disturbances and vegetation management activities make up most of the annual human-caused fragmentation in actively managed portions of the Forest. These areas typically re-vegetate within ~~three~~3 to ~~five~~5 years, depending on the forest type and number and type of activities (USDA 2011, p. 119). The Forest Plan (USDA 2004a, ~~A~~appendix E) provides direction on limiting lynx habitat fragmentation, and the Forest actively consolidates habitat through land acquisitions and exchanges.

5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Expert Projections of Future Lynx Status

Because of its connectivity to lynx populations and habitats in Canada, its large geographic extent, and the relatively large number and broad distribution of resident lynx it is thought to support, future extirpation of lynx from this unit due to reduced genetic health or a catastrophic event is unlikely (Lynx SSA Team 2016, pp. 25-34). When considering the probability that this unit would continue to support resident lynx in the future, experts noted that despite projected losses of favorable forest and snow conditions, climate models project that some boreal forest will persist in this unit and that it will maintain some areas of suitable snow into the future. Experts also noted that lynx in this unit primarily occupy public lands, which are actively managed for lynx into the future. Experts also considered recent and projected future increases in wildfire frequency, size and intensity.

As for most other geographic units, all experts indicated an initially high and subsequently decreasing probability of the persistence of resident lynx in this unit, with increasing uncertainty over time, but a higher probability of persistence at all time frames than other units. All experts predicted near-term (year 2025) persistence probability >= 95%, mid-century persistence at 70% to 100% (median = 90%), and end-of-century persistence probabilities >= 50% (median = 78%) (Figure 10, below).

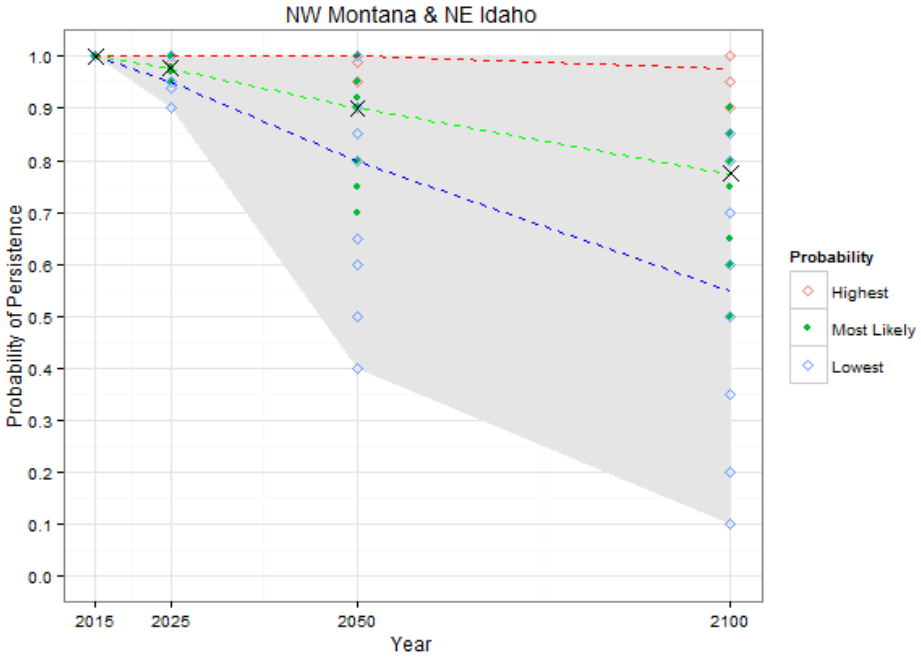


Figure 10. Lynx expert estimates of the probability that the Northwestern Montana/Northeastern Idaho Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Overall, experts assigned a higher probability of persistence in this unit compared to the other geographic units. Most lynx habitats in this unit occur on federal lands that are managed for lynx conservation, but one expert noted that little has been done to document whether lynx are responding to this management. The recent sale of large tracts of private commercial timberlands in the central part of this unit to The Nature Conservancy has increased protection for lynx via conservation easements managed for lynx. Habitats in some areas should improve in the near future as previously cut or burned areas mature into dense stands. Unlike the Maine and Minnesota geographic units (but similar to most other western units), high elevations in this unit could buffer the effects of climate change by providing for the upslope migration of lynx habitats and snow conditions that climate models predict. However, this would result in even patchier and more isolated islands of habitat in high elevation areas that would be more prone

to extirpation due to catastrophic or stochastic events. Competition from coyotes and bobcats seem to be less of a concern for this unit.

This unit has unimpeded connectivity with Canada, but some experts questioned whether this geographic unit depends on intermittent immigration of lynx from Canada, and whether the historic lynx population cycles in Canada believed to have fueled such immigration are still occurring or will into the future. There doesn't appear to be much demographic input from recent cycles. There is evidence of lynx from this unit moving north into Canada, but little evidence of demographic interactions among the three subpopulations (Purcell Mountains, Seeley Lake, and Garnet Mountains) in this unit. Experts noted that the Garnets Mountains subpopulation at the southern end of this unit may have recently become extirpated.

Discussion among experts indicated that fire was more of a concern for this area. Increased fire extent and severity or other catastrophic events and small subpopulation effects in separated mountain ranges could affect lynx persistence in the future in some parts of this unit. Fire exclusion in this area for the last 100 years likely resulted in the accumulation of fuels; however, this unit may have a reduced probability of a catastrophic fire over time because of recent changes in management and recent fires that may have reduced fuels. Out to the year 2050 and beyond, some experts felt there may be more pressure on lynx populations in this unit from continued increases in fire extent and severity. Other experts expressed a different opinion of the overall effect of fire in this unit, indicating that it may actually improve habitat over time, and that whether fires improve or degrade habitat depends on the frequency, intensity, size and spatial extent of future fires.

Experts discussed the possibility for increased precipitation and warmer temperatures in this unit because of climate change, and how this might affect lynx habitats. Boreal/subalpine forest may move up in elevation as described above; however, experts expected a shift in forest composition and diminished lynx habitat quality in future with climate change. It is unknown how much the distribution of dry ponderosa pine (non-habitat for lynx) will increase with climate change, but it is likely to happen at some level. One expert cautioned that some climate modelers estimated that vegetation will lag about 50 years behind the projected changes in temperature and precipitation. Snow levels in lower elevation areas are already decreasing in some areas, which could lead to smaller areas for lynx to use in winter in the future.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - Federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Because most (84 percent) of this geographic unit consists of ~~f~~Federal lands, the regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations in this unit. When Forest Service, Park Service, and BLM management plans are revised or amended, they require opportunities for public participation in accordance with several statutes (e.g., the National Environmental Policy Act [NEPA], National Forest Management Act [NFMA], National Parks and

Recreation Act, Federal Land Policy and Management Act [FLPMA]) (USFWS 2014 pp. 26-34, also see 3.1, above). If plan amendments or revisions may affect listed species, management agencies must consult with the Service in accordance with section 7 of the ESA. If in the future the lynx DPS is determined by the Service to be recovered and the protections of the ESA no longer necessary (i.e., if the DPS is removed from the *Federal Lists of Endangered and Threatened Wildlife and Plants*), the ESA requires the Service, in cooperation with the States, to monitor the DPS for a minimum of ~~five~~5 years to assess its ability to sustain itself without the ESA's protective measures. If, within the designated monitoring period, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future ~~f~~Federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (BLM 2004a, pp. 2-3; USFS 2007, Attachment 1, p. 2). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore the capacity of the areas that historically or recently supported resident lynx populations, including the Northwestern Montana/Northeastern Idaho Geographic Unit, to continue to do so in the future.

On non-~~f~~Federal lands (about 16 percent of this unit), as described above (sections 3.1.1 and 4.2.3, Habitat Status), recent acquisitions and conservation easements on some of the private lands in this unit will also reduce the likelihood of future adverse impacts to important lynx habitats. Similarly, the MTDNRC HCP includes a 50-year commitment to manage most (64

Comment [MJM72]: See my comment at beginning of Chapter 5 about establishing the proper context for evaluation of status. That context requires we evaluate status assuming he lynx is not currently listed. Our assessment would take into account everything that would be different if the lynx were not listed, not just Federal management.

Also, if this correct context is established, it's not appropriate or necessary to describe what will happen if we were to delist the DPS – we' will have already established a context of the lynx not being listed. We don't need to envision how the world will change as a consequence of going through the delisting process (and initiating postdelisting monitoring); we simply need to envision he world without the lynx being listed.

In envisioning the world without the lynx being listed, we can and should still assess how Federal agencies, states, landowners, etc. will act in a world where future lis ing of the lynx is a possibility. So, the prediction here that Federal management will continue to be protec ive of lynx (so as to avoid a possible future listing) is OK, but the way we get to his conclusion needs to be revised.

This kind of analysis needs to be done for all units and for all actors (Federal agencies, states, landowners, etc.) and for all consequences, not just regulatory mechanisms.

percent) State lands in this unit to conserve lynx foraging, denning, and connectivity habitats. Additionally, the Confederated Salish and Kootenai Tribe's objective to manage wildlife and habitats on the Flathead Reservation for future generations (section 3.1.2, Tribal Management, above) suggests continued management to conserve lynx habitats on Tribal lands.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will continue to support resident lynx into the future.

If the DPS ~~were to be delisted in the future~~was not listed, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Comment [MJM73]: Suggest addressing this in each unit analysis.

Comment [MJM74]: Why? Have the states expressed this reasoning as part of their operating principles? If so, cite this evidence.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.3, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 41). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but

habitat quality, quantity, distribution, and connectivity are expected to decline, likely compromising this unit's continued ability to support resident lynx populations.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, and to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on future lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of these landscapes to continue supporting resident lynx may be compromised, and lynx populations may be unable to persist until favorable vegetation conditions return. This is especially true where habitats and populations are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much if not all of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced (as is suspected) by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will reduce this geographic unit's ability to continue to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx populations in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will reduce future habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal and most non-federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.3, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted

there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.3, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although this increased wildfire activity does not appear to have diminished this unit's current ability to support resident lynx, it could do so in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support a resident lynx population until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.3, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy

development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – As described above and in section 4.2.3, maintaining connectivity between this geographic unit and lynx populations in Canada is thought to be important, although it is uncertain if or to what degree immigration of lynx from Canada is essential to the persistence of lynx in this unit. A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and a reduced probability of persistence among resident populations would be expected.

Although the extent to which this factor may influence lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. If this growth rate was applied continuously to a hypothetical resident population of 250 lynx (the midpoint of the range in the number of resident lynx this geographic may support based on expert opinion [Lynx SSA Team 2016, p. 41]), the population would decline to 100 lynx after 11 years, about 50 lynx after 20 years, and roughly 20 individuals after 30 years. Vulnerability to demographic, environmental, and genetic stochasticity would increase as lynx numbers decreased, resulting in an increased likelihood of functional extirpation of lynx from this unit. However, as noted above, the lynx population in the Purcell Mountains in the northwestern part of this unit was estimated to be increasing ($\lambda = 1.16$, 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) over the last four years of the period for which the Seeley lake population was estimated to be declining. In the absence of information on historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.4 Unit 4 - North-central Washington

Expert Projections of Future Lynx Status

Compared to the previous units, most expert graphs showed a lower probability of persistence for this unit over the short term, and then lower probability of persistence along with increasing uncertainty by 2100, reflecting a more pessimistic outcome for this unit compared to previous units (Figure 11). Experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), and mid-century persistence at 30% to 80% (median = 70%). All experts predicted end-of-century persistence probabilities less than 50%, with a median of 38%, by 2100 (Figure 11). However, one expert predicted an increase in persistence probability by mid-

century as habitats impacted by recent large-scale fires regenerate into optimal hare-lynx habitat.

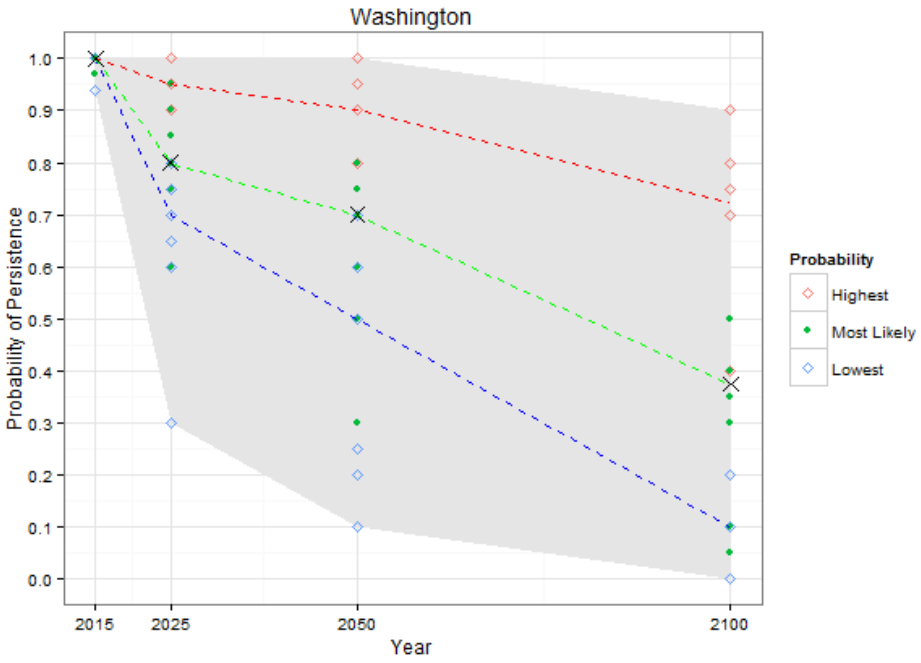


Figure 11. Lynx expert estimates of the probability that the North-central Washington Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

The probability of lynx persistence in this unit could decrease sharply over the next 10-20 years because of extensive recent fires in lynx habitats and the time needed for these areas to regenerate back to good hare/lynx habitat. After that, the probability could rebound (or decline more slowly) over the longer term as these large areas return to prime habitat providing high hare densities. The current small population is likely at greater risk of extirpation because of stochastic events, particularly if large fires in lynx habitat continue to occur in the near future as they have in the recent past. A small population also could be more susceptible to disease, though none has been documented among lynx in this unit. Experts discussed the extent to which small lynx populations could be reduced before they would become highly susceptible to stochastic demographic effects. It was suggested that 15-20 breeding individuals might be the minimum needed to avoid such susceptibility. Unimpeded connectivity between Canada and the Okanogan area of this unit could allow lynx to repopulate currently-unsuitable areas after the habitat recovers. Lynx in this unit are likely the southern portion of a larger population in

Canada, not really a separate, isolated small population. Factors that influenced expert persistence probabilities for this unit included fire, habitat loss, and the future loss of favorable snow conditions predicted by climate change models.

Service Evaluation of Factors Influencing Future Conditions

Regulatory Mechanisms - As stated previously, it appears that, currently, adequate protective regulatory mechanisms are in place in this geographic unit. Looking to the future, relative to the regulatory risks to lynx, we do not anticipate the existing regulatory protections for lynx to diminish. We anticipate that either the CA will remain in place (and/or be extended), or the OWNF and CNF will revise or amend their respective LRMPS incorporating direction for lynx management similar to what has occurred with other 18 National Forests in Idaho, Montana, Utah, and Wyoming. These 18 National Forests amended their respective LRMPs with lynx management direction known as the Northern Rockies Lynx Amendment (NRLA) in 2007. The NRLA incorporated management recommendations from the LCAS, with modifications based on the advent of new information pertaining to the management of lynx. Currently, both the OWNF and CNF are in the process of amending or revising their LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended LRMP. Also, as discussed previously, the WADNR has developed and is implementing its 2006 Lynx Plan. The WADNR commits to implementing the 2006 Lynx Plan until lynx are delisted or until 2076, whichever is shorter (WADNR 2006, p. 6). Thus, it appears the regulatory future of lynx management, and thus, lynx habitat management, is largely secure on both federal and state managed lands within Washington State.

Comment [MJM75]: Need to specifically what we expect if lynx were not listed.

Climate Warming - The one risk factor identified by the LCAS over which the Forest Service, or the WADNR for that matter, has little ability to control or influence is climate change. Climate change was identified by the panel of lynx experts convened during development of the Canada Lynx Expert Elicitation Workshop Report to potentially represent the greatest threat to the long-term persistence of lynx (Lynx Workshop Report 2016, p. 56).

Potentially further exacerbating the recent losses of lynx habitat from fires is climate change. Climate change may affect fire return intervals and severity as well as the quality and depth of snow within lynx habitat. Westerling *et al.* (2006, pp. 942-943) compiled information on large wildfires in the western U.S. from 1970-2004 and found that large wildfire activity has increased significantly from the mid-1980s with large-wildfire frequency, longer wildfire duration, and longer wildfire seasons. The greatest increases occurred in high elevation forest types including lodgepole pine and spruce fir in the northern Rockies (i.e., lynx habitat). They also found that fire exclusion had little impact on natural fire regimes. Rather, climate appeared to be the primary driver of increasing wildfire risk. As stated previously, Koehler's (1990, p. 847) estimated adult lynx density of 2.3 lynx/100 km^2 was obtained in an area supporting high quality lynx habitat in the Meadows area of north central Washington (at least relative to other lynx habitat in Washington). Much of the lynx habitat in the Meadows was impacted by the recent large, stand replacing fires in the Cascades, resulting in further fragmentation of lynx habitat in

the northern Cascades. Thus, the lynx densities Koehler observed in his study area may not be currently supported, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines.

Additionally, relative to the persistence of Washington's lynx population, during the lynx expert elicitation workshop several of the lynx experts expressed concern that should more wildfires occur within the next 10 years and result in losses of lynx habitat similar to the impacts caused by the recent wildfires, such wildfires could result in the functional extirpation of lynx in Washington. The experts expressed heightened concern of functional extirpation of lynx in this geographic unit from wildfires due to its small size and current lynx population (Lynx Workshop Report 2016, p. 27). However, the experts felt the potential extirpation of lynx, should it occur from a large catastrophic wildfire(s) (or other mechanisms such as insect outbreaks), may be ameliorated to some extent due to Washington's juxtaposition and connectivity to Canadian lynx populations. The experts felt that lynx immigration from Canada may rapidly recolonize Washington as the habitat recovers from fires or other impacts (Lynx Workshop Report 2016, p. 43). Climate change, in addition to potentially affecting fire return intervals, fire severity (intensity, size), and insect outbreaks, is likely to affect the amount of precipitation falling as snow at elevations typically supporting lynx habitat in this geographic unit.

Lynx survive in areas with cold, snowy winters providing deep, fluffy snow (78 FR 59443) that gives lynx competitive advantages over other competitors and predators of lynx, as well as providing the conditions supporting the lynx's main prey, the snowshoe hare, which can comprise as much as 97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448).

Climate change may impact the quantity, quality, and temporality of snow in the Cascades. Mote (2003, pp. 272, 274), who evaluated temperature trends in the Pacific Northwest using data collected by weather stations from 1930 to 1995, determined that the temperature increased in the Pacific Northwest, and more precipitation fell in the spring and summer months, especially at elevations below 1,800 m (5,900 ft). Additionally, Mote (2003, pp. 2-3) determined that an increasing temperature and precipitation trend from 1950 to 2000 is correlated with a 40 percent decrease in the snow water equivalent in the Cascades. Mote *et al.* (2005, p.45) determined that the Cascades are very sensitive to temperature changes, with large increases in temperature potentially resulting in significant declines in snowpack. Corroborating Mote's speculation, Stoelinga *et al.* (2010, p. 2474) determined that the Cascade snowpack has declined by up to 40 percent in the latter half of the twentieth century, which resulted from increased temperatures. Furthermore, predicted continued increasing temperature changes of 2° C to 5° C over the next century are expected to cause further and accelerated losses in snowpack in the Cascades (Mote *et al.* 2005, p. 48). Continued declines of snowpack in the Cascades through 2025 are predicted to range from 9 percent (Stoelinga *et al.* 2010, p. 2486) to 29 percent (Elsner *et al.* 2010 *cited in* Stoelinga *et al.* 2010, p. 2486), which may also affect lynx densities supported in the Cascades. Finally, some of the best lynx habitat in this geographic unit occurs on plateaus that may be more vulnerable to impacts of climate change because of the absence of higher elevation areas to which habitats and lynx could migrate in response to

climate warming (Lynx Workshop Report 2016, p. 42). Thus, in addition to the recent losses of lynx habitat to large wildfires, coupled with increasing wildfire risk, the potential for the Cascades to support a viable lynx population may be further reduced due to decreasing quantity and quality of snow.

Similar to the potential effects of wildfires on the persistence of the lynx population in this geographic unit, the lynx experts identified climate change relating to loss of favorable snow conditions as a significant factor potentially affecting the long-term persistence of this population (Lynx Workshop Report 2016, pp. 43-44). Taking all factors into consideration (i.e., catastrophic wildfire, insect outbreaks, loss of snow), the experts felt the probability of this population persisting to the year 2050 most likely ranged between approximately 60 percent to 80 percent, declining by the year 2100 to approximately 30 percent to 50 percent (Lynx Workshop Report 2016, p. 43).

5.2.5 Unit 5 - Greater Yellowstone Area

Expert Projections of Future Lynx Status

The expert graphs for this unit were widely variable and had different outcomes and high uncertainty at all time frames. Experts predicted near-term (year 2025) persistence probabilities of 10% to 70% (median = 52%), and mid-century persistence at 15% to 60% (median = 35%). All experts predicted end-of-century persistence probabilities less than 50% for this unit, with a median of 15%, by 2100 (Figure 12). This was the only unit for which most experts believed the present probability of persistence is low (i.e., that it is uncertain whether this area currently supports a resident lynx population). Some experts increased probability of persistence into mid-century as the 1980s-era fires regenerate into hare/lynx habitat, and with the possibility of continued immigration of lynx from Colorado. Other experts project a 10% to 20% probability of persistence by 2100. One reason given for wide variability in responses is because of the uncertainty whether a population currently exists. There were wide confidence intervals around the probabilities for all time periods for this area.

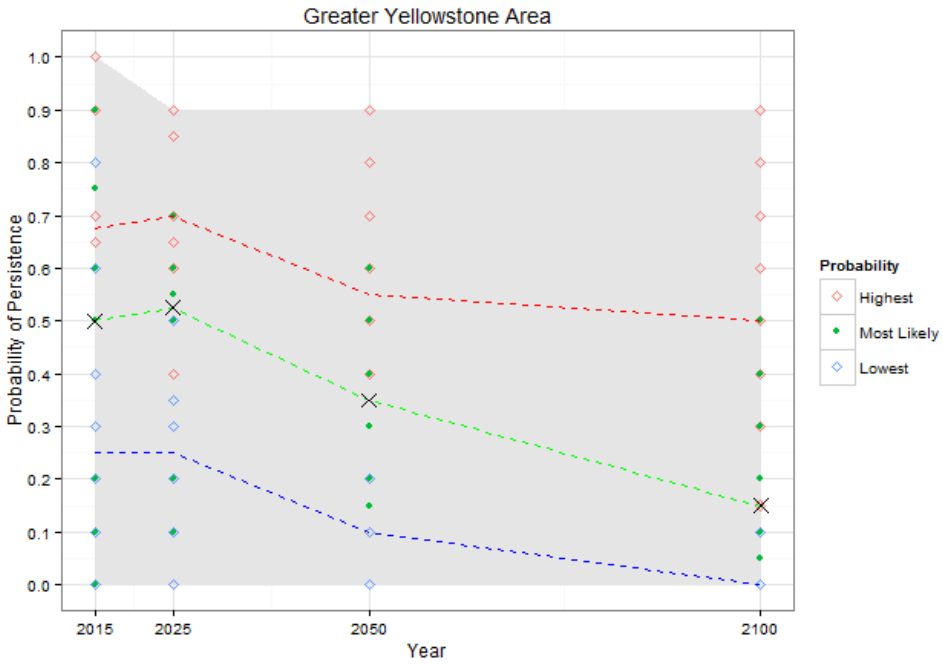


Figure 12. Lynx expert estimates of the probability that the Greater Yellowstone Area Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Current and future factors expressed by experts as influencing probability of persistence for this unit included small population size, forest disease and insect pests, and fire. Some experts doubt that the GYA unit currently supports a resident breeding population of lynx. Experts indicated that climate models predict that some parts of the GYA unit could provide refuge from climate change impacts because of their high elevations and potential to maintain winter snow levels into the future. Summer conditions in this unit, however, could be drier in the future, resulting in increased fire frequency, extent and intensity, and additional temporary habitat loss. However, regeneration of these areas and the extensive areas that have burned in the recent past may provide good habitat over the next several decades. Lynx immigrating to this unit from Colorado could occupy such improved habitats in the near future. Colorado lynx have made exploratory movements into the GYA in summer months, and analysis of available data could improve our understanding of Colorado lynx movement into and use of the GYA. It is possible that lynx from Colorado are maintaining or could maintain lynx in GYA.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - As noted above in section 5.2.3, federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Federal lands account for over 97 percent of this geographic unit; therefore, regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations. Also as described above, revisions or amendments to federal management plans require opportunities for public participation in accordance with NEPA, NFMA, National Parks and Recreation Act, and FLPMA (USFWS 2014 pp. 26-34; also see 3.1, above) and consultation with the Service in accordance with section 7 of the ESA. If the DPS were to be recovered and delisted in the future, the ESA requires a minimum of five years of monitoring to assess its ability to sustain itself without the ESA's protective measures. If, during that time, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historic disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (USFS 2007, Attachment 1, p. 2; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued federal management designed to conserve or restore potential lynx habitats in this geographic unit in the future.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support

conservation and restoration of lynx habitats in this unit and improve the likelihood that it will support resident lynx into the future. Because non-federal lands make up such a small proportion of this geographic unit, we believe it is unlikely that regulatory mechanisms on those lands will influence this unit's future ability to support resident lynx.

If the DPS ~~were to be delisted in the future~~was not listed, State-managed trapping could resume in this geographic unit. We expect that would occur only if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Comment [MJM76]: See previous related comment.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.5, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 46). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely further compromising this unit's ability to support resident lynx populations, which is already questionable.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, including the extensive fires in Yellowstone National Park in 1988, which burned over one-third of the park. Climate warming has also been linked to increased frequency

and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of landscapes in the GYA to support resident lynx may be further compromised, and resident lynx may be unable to persist until favorable vegetation conditions return. This is especially true where potential habitats are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will further reduce this geographic unit's ability to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx and habitats in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historic and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will further reduce habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.5, above, past wildfire management, including fire suppression, does not appear to have altered the historic fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current Ffederal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.5, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although the extent to which increased wildfire activity has impacted this unit's current ability to support resident lynx is uncertain, such impacts may become more likely in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand- initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support resident lynx until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity due to climate change, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.5, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation due to timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – This geographic unit is not directly connected to lynx populations in Canada or elsewhere in the DPS range, although lynx released into Colorado have dispersed northward into and through this unit. There is little evidence of intermittent

immigration into this unit during past irruptions of lynx from Canada, as has been documented in other parts of the contiguous U.S. Nonetheless, as elsewhere in the DPS, immigration may influence the persistence of resident lynx in this unit. If continued climate warming or other factors further reduce the chances that dispersing lynx will reach this unit and contribute to its demographic and genetic health, either through habitat loss and fragmentation in potential dispersal corridors or declines in the amplitude of northern hare and lynx population cycles, the likelihood that the unit will support resident lynx in the future may also decline. However, as in Unit 3 above, because we lack information of historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

5.2.6 Unit 6 - Western Colorado

Expert Projections of Future Lynx Status

The majority of the experts suggested an initially high probability of persistence in Colorado, declining gradually with increasing uncertainty through the end of the century. Experts predicted near-term (year 2025) persistence probabilities of 60 percent to 100 percent (median = 90 percent), and mid-century persistence at 50 percent to 85 percent (median = 80 percent). Experts predicted end-of-century persistence probabilities of 20 percent to 70 percent for this unit, with a median of 50 percent, by 2100 (Figure 13).

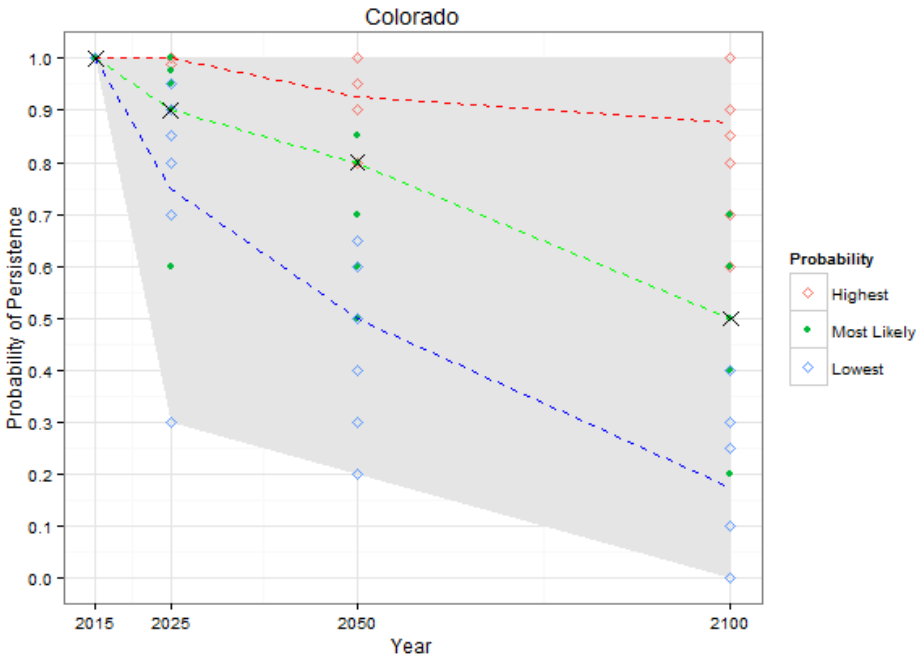


Figure 13. Expected probability of persistence for the Western Colorado Geographic Unit at present, 2015, and in 2025, 2050 and 2100.

Some experts indicated that beetle kill and fire could potentially create poor habitat conditions in large areas of this unit by mid-century, but that regeneration after these impacts could result in good lynx/hare habitats. Others expressed uncertainty about whether fire and insect impacts would be temporary or permanent, especially considering climate change and the potential for conversion from boreal/subalpine forests to other forest types. Although 8 of 10 experts graphed 50 percent to 70 percent probability of persistence at 2100, during subsequent discussions, several expressed greater uncertainty about whether resident lynx will persist in the unit at the end of the century. Higher-quality lynx habitat occurs primarily in two areas and is patchily-distributed. Lynx in this unit may occur as several smaller, relatively isolated subpopulations, which are likely more vulnerable to stochastic events. This unit's relative isolation may limit exchange with other lynx populations, increasing the likelihood of genetic drift and reducing the chance of demographic rescue or recolonization if lynx in the unit become extirpated. There was discussion about whether ski areas may affect daily movements of lynx, and hares may be declining in ski areas. Ski areas tend to expand and may, therefore, have larger impacts on lynx in future. There is some evidence of lynx using ski areas in summer months but avoiding them during the ski season. It is uncertain whether ski areas may affect genetic connectivity within the Western Colorado geographic unit. Two-thirds to three-quarters of the lynx in this unit are in the southern portion of the range in the San Juan Mountains. There is a large area (Weminuche

Wilderness) in Colorado that has not been well surveyed for lynx, so it is possible that lynx also could be using that area.

Service Evaluation of Influencing Factors

Regulatory Mechanisms - Regulatory mechanisms for the conservation of lynx in the Southern Rockies consist of seven amended USFS management plans in south-central Wyoming, and Colorado. We concluded that the Southern Rockies Lynx Amendment substantively reduced the inadequate regulatory mechanisms by addressing the major adverse impacts of Forest Service land management on lynx (Service 2008, p 70-71). Lynx habitat on all other ownerships makes up the remaining 15 percent of lynx habitat in Colorado, of which, only five percent is in federal ownership. Other ownerships include state, county, municipal, etc., and private lands. The BLM resource management plans have not been amended to include conservation specifically for lynx and, with a few exceptions. Lynx habitat on BLM ownership mostly consists of narrow forest extensions connected to larger blocks of habitat on adjacent USFS lands. Generally these extensions are insufficient on their own to support a lynx home range. However, the Gunnison Field Office is the only BLM unit that contains sufficient habitat to map and identify LAUs.

The State of Colorado manages lynx as a state endangered species C.R.S. 33-2-105, prohibiting take of the species with exceptions for protection of human life (C.R.S. 33-6-205 and incidentally during depredation management (not caused by lynx) [C.R.S. 33-6-207].

Climate Change - ILBT (2013 p. 61) – “Climate change generally is expected to result in warmer winters, earlier spring snowmelt, and a reduction in the extent of snow cover in the southern Rockies. McKelvey *et al.* (2011 entire in ILBT 2013) used a variety of climate models to predict snow depth and the persistence of spring snow across the western United States. The models predicted an overall decline in persistent snow of 40 percent, but large areas of persistent snow would continue to be retained late in the 21st century, including the high elevations of Colorado.”

“All of the climate models under all representative concentration pathway (RCP) project that Colorado’s climate will warm substantially by 2050. Under RCP 4.5 (medium-low emissions scenario), Colorado’s annual temperatures are projected to warm by +2.5°F to +5°F by mid-century relative to 1971–2000 observed baseline. Under RCP 8.5 (high emissions scenario), Colorado’s annual temperatures are projected to warm by +3.5°F to +6.5°F by mid-century. Summers are projected to warm slightly more than winters under both RCPs. Looking beyond the 2050-centered analysis period, the warming trend is projected to continue into the late-21st century under all RCPs except RCP 2.6. By the period centered on 2070 (2055–2084), the projected warming in Colorado annual temperatures under RCP 4.5 is +2.5°F to +6.5°F relative to the 1971–2000 baseline. Under RCP 8.5, the projected warming is +5.5°F to +9.5°F relative to the 1971–2000 baseline.” [Lukas *et al.* 2014 page 61]

An analysis of projected 21st century temperature trends as a function of elevation in the Northern Hemisphere mid-latitudes from CMIP5 models shows more warming at higher

elevations during winter, particularly in the daily minimum temperature (Rangwala *et al.* 2013 [cited in Lukas *et al.* 2014 page 63]). “However, as discussed in Section 3, the global climate models do not represent the topography of Colorado very well, so it is difficult to discern whether the warming projected for the higher elevation regions (>10,000’) in the state is substantially different from that projected for lower elevations” (Lukas *et al.* 2014 page 63).

On average, the climate models indicate a seasonal shift in precipitation for Colorado, with increasing winter precipitation, and in some areas a decrease in late spring precipitation (Lukas *et al.* 2014, page 65).

Vegetation Management - In the past decade, vegetation management within lynx habitat has been predominantly salvage of dead and dying timber caused by a mountain pine beetle infestation in the northern part of the state (generally north of Interstate 70), and a spruce bark beetle infestation south of the interstate. Salvage operations may temporarily impact understory regeneration, if present, reducing the capacity of the stand to support higher snowshoe hare densities. Assuming the existing US Forest Service plans retain their current conservation framework, USFS lands should continue to provide sufficient habitat for lynx through the end of the century.

Vegetation management on non-federal ownerships within lynx habitat is unlikely to cause significant concern for lynx conservation in Colorado through the remainder of the century.

Wildland Fire Management - “It is generally acknowledged that in the Southern Rocky Mountains fire suppression has altered historic vegetative patterns. This effect has been most pronounced within vegetation communities where fire regimes are of low intensity or mixed severity. It is generally agreed that spruce-fir habitats have been little affected by fire suppression because the fire regimes within this type tend to be stand-replacing events occurring at long intervals (100+ years). Depending on the moisture regime, large stand-replacing fires within lynx habitat may produce young age class snowshoe hare habitat after approximately 10-30 years. Although this vegetative condition may provide some high quality snowshoe hare habitat, mature forests are also very important as winter foraging habitat.” (USFS 2008 page 36)

Habitat Fragmentation - Sources of current habitat fragmentation include high-speed high-volume highways, high mountain valley developments, vegetation management, ski/recreation area development, and wildland fire. Currently, only vegetation management on USFS lands is managed to limit lynx habitat fragmentation. Highways are likely to be expanded to accommodate increasing traffic volume as mountain valley communities continue to be developed and expended. While these linear features already exist on the landscape, widening of the cleared right-of-way, as well as behavioral avoidance of highway rights-of-way due to traffic reduces available habitat. Many ski areas in Colorado are located within lynx habitat and will likely be expanded in the future through permanent removal of vegetation to create conventional ski runs, reducing tree density and clearing understory vegetation to create glade conditions, reduces lynx habitat. The magnitude of fragmentation caused by these sources of

has not been quantified, but is unlikely to remove enough habitat to eliminate the possibility of lynx persistence in Colorado.

Chapter 6: Synthesis

This section synthesizes the needs, current condition, and likely future condition of the Canada lynx in the contiguous U.S. DPS with respect to the conservation biology principles of representation, redundancy, and resiliency. Its purpose is to provide an understanding of the range-wide status of this DPS that is as clear as possible given the unavoidable uncertainties involving demography and long-term threats.

Comment [MJM77]: See my comments on executive summary, which pulls many of the conclusions form this chapter. I did not repeat hose comments here.

Comment [MJM78]: Where do we explain whether we agree or disagree with the experts' opinions and why? The "Service evaluation" for each unit seems to be independent of he discussions about the preceding "Expert Projections" for each unit I was expecting this explanation to be in he Service evaluations or here.

Needs

Throughout the species' range, the lynx is a habitat and prey specialist requiring boreal forests with dense horizontal cover, long winters, and deep, fluffy snow, which gives it a competitive advantage for exploiting its primary prey, the snowshoe hare. Lynx in the contiguous U.S. have ecological requirements similar to those of lynx in Canada and Alaska, and throughout the species' range hare abundance is the primary driver of lynx population dynamics. However, the DPS is at the southernmost margin of the species' range, where boreal forests transition to temperate conifer and hardwood forests, and where snow conditions and hare abundance generally become less favorable with decreasing latitude. Because of this, habitat is less extensive and generally more fragmented within the DPS range than in the core of the species' range in Canada and Alaska. As a result, lynx in the contiguous U.S. are naturally less abundant and more patchily distributed than in the core of the range. Maintaining connectivity between lynx populations in Canada and the DPS is thought to be important; however, whether and if so to what extent the demographic and/or genetic health of DPS populations relies on periodic immigration from Canadian populations remains uncertain.

Current Conditions and Threats

Resiliency, the ability to withstand stochastic disturbance events, and redundancy, the ability to withstand catastrophic events, are currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. Available information indicates that five out of six geographic units in the DPS contain resident breeding lynx populations. Although we have no reliable population-size estimates for any of the geographic units, Northern Maine (Unit 1) is believed to currently support the largest resident population in the DPS. In Northeastern Minnesota (Unit 2), a resident population occupies the Arrowhead Region of the State. Northwestern Montana and northeastern Idaho (Unit 3) continue to support resident lynx, although a small subpopulation in the Garnet Mountains on the southern periphery of this unit may have been extirpated recently. In North-central Washington (Unit 4), recent extensive wildfires have temporarily reduced the amount of high-quality lynx habitat and may have caused a decline in lynx numbers there. Since the release of Canadian and Alaskan lynx in 1999-2006, resident lynx currently occupy western Colorado (Unit 6). The Greater Yellowstone Area (GYA, Unit 5) is thought to have historically supported a small

resident population; however, resident lynx have not been documented recently in this unit. The apparent long-term (historic and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historic conditions suggest the historical and recent resiliency of lynx populations in the DPS. The large sizes and broad geographic distributions of the areas occupied by resident lynx populations likewise indicate adequate historical and current redundancy in the DPS to preclude its extirpation because of catastrophic events.

Representation, the ability of a species to adapt to changing environmental conditions over time, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Information provided by lynx experts and geneticists indicates high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Hybridization with bobcats has been documented but is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Thus, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historic conditions.

The primary threat identified at the time of listing, lack of regulations protecting lynx habitat on federal lands, has been largely addressed by formal and binding amendments or revisions to most federal land management plans within the DPS range. Although questions remain about the efficacy of this improved regulatory framework, federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands. Most federal lands, which constitute 64 percent of lynx habitat evaluated in this SSA, are found in the western U.S.

Other stressors affect lynx in one or more geographic units. For example, in northern Maine, where most high-quality lynx habitat occurs on private commercial timber lands and is the result of past timber harvest, changes in State forestry regulations (the Maine Forest Practices Act of 1989) that govern private forest management may currently be causing decreases in habitat quantity, quality, and distribution, and in lynx numbers (also see *Future Conditions and Threats*, below). The lack of binding lynx conservation commitments on private lands may exacerbate this risk to current lynx habitats in Maine. In North-central Washington, recent large-scale wildfires have resulted in the temporary loss of nearly 50 percent of lynx habitat, likely reducing this unit's current lynx population and potentially compromising its current ability to support a

resident population until habitats recover. Increased wildfire activity also has impacted lynx habitats in the other western geographic units (Northwestern Montana/Northeastern Idaho, the GYA, and Western Colorado), but the extent to which it has influenced the current condition of lynx populations in those units is uncertain.

Climate change is occurring at a global and, thus, a DPS-wide scale. Climate warming has reduced snow amount, duration, and quality (in terms of conditions favorable for lynx), it has been linked to increased frequency, size, and severity of wildfires and forest insect outbreaks, and it likely has already resulted in some changes in forest vegetative communities. Climate warming has also been linked to changes in the amplitude, periodicity, and synchronicity of northern hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in the DPS depend on immigration from Canada which is no longer occurring or has been substantially reduced relative to historic conditions, population declines and an increased likelihood of extirpation among resident populations would be expected. However, whether, and if so to what extent, these climate-mediated factors have influenced current lynx numbers, other demographic parameters, and/or habitat quality and distribution is uncertain and has not been quantified across the range of the DPS or in individual geographic units. Despite uncertainty regarding its influence over current conditions for lynx, climate modeling and expert opinion concur that continued climate warming will adversely impact lynx in the DPS in the future (see below).

Future Conditions and Threats

Overall, ~~expert opinion and~~ our evaluations suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations) (Lynx SSA Team 2016, p. 58). Forest management on private lands that lack lynx conservation commitments may also contribute to future declines, particularly in northern Maine. In each geographic unit, the probability that resident lynx populations will persist is expected to decline. The loss of resident lynx from one or more geographic unit would represent reduced future resiliency, redundancy, and representation within the lynx DPS.

The resiliency of lynx populations in individual geographic units is the primary determinant of the future viability of the lynx DPS. ~~Expert opinion and o~~Our analyses suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the

timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible to stochastic events.

The loss of any geographic units would also reduce the level of redundancy and could diminish representation within the DPS. With regard to redundancy, however, neither the scientific literature nor expert input provide a basis for concluding that any single future catastrophic event could cause extirpation in any one geographic unit. It is even less likely that a single future catastrophic event (other than climate change, which we considered as a separate stressor) will eliminate all populations in the DPS. A sequence of catastrophic events over a short time could increase the potential for functional extirpation of one or more of the individual geographic units (e.g., fires in north-central Washington, as described above), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation from a catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and likely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Furthermore, based on expert input, we conclude that there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS. How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Comment [MJM79]: Does this document explain how we arrive at this conclusion? If so, summarize it here. And do this for every conclusion.

Given the high percentage of federal land ownership in the West, regulatory commitments that these lands will continue to be managed in accordance with lynx conservation principles, and

the existence of potential high-elevation climate refugia to which lynx habitats and some lynx might move, the western geographic units (Units 3-6) may be more likely to support resident lynx longer under projected continued climate warming. Nonetheless, it is unlikely that any management actions can abate the long-term retreat of boreal forests and diminished snow conditions projected by climate models. Further, the size, frequency, and intensity of wildfires and forest insect outbreaks are expected to increase with continued climate warming, particularly in the western portion of the DPS, although we do not anticipate such events in-and-of-themselves are likely to cause the permanent loss of breeding lynx populations in any geographic unit.

Although projections of climate-mediated losses of boreal forests and favorable snow conditions suggest impacts to lynx and hare populations throughout the DPS, persistence of resident lynx in Maine and Minnesota may be relatively lower than the western geographic units given the smaller percent of federal lands and the absence of associated regulatory commitments to lynx conservation, and the lack of potential elevational refugia. Additionally, as noted above, changes to regulations governing timber harvest on private forest lands in Maine are unlikely to maintain the current historically-high amount and distribution of good lynx habitat or the current large population of resident lynx. These changes, which may affect over 90 percent of lynx habitats in northern Maine, are projected to result in substantial declines in habitat quality and distribution, and lynx numbers, over the next 10-30 years, primarily through restrictions on clearcutting and the proliferation of partial harvesting, which are detrimental to snowshoe hare and lynx needs. On private forest lands, energy development (wind energy, mining), rapid turnover in ownership and parcelization of forest land, and uncertain forest markets may also reduce the future quality and quantity of lynx habitat.

DPS viability

Although all five geographic units that currently support populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century (Lynx SSA Team 2016, pp. 36-49, 58). All other geographic units have a 50 percent or greater expert-estimated probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century, with a moderate to high likelihood that resident lynx will be lost from two to four units by then. Potential elevational refugia may increase the likelihood of persistence in western units, although uncertainty remains about the timing of warming-driven upslope movements of habitats and snow conditions and the extent to which hare and lynx populations may follow them. Regardless, future lynx habitats throughout the DPS range are likely to be smaller and more fragmented, and geographic units that are already relatively isolated from other lynx populations are likely to become even more isolated in the future. Despite the lack of elevational refugia, lynx may also persist at the end of the century in Maine and Minnesota, depending on the timing and severity of climate change effects and, in Maine, on trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the

Comment [MJM80]: We never say whether we agree or disagree with hese specific experts' opinions and explain why. We make a meaningless statements in the end about probability of persistence, and that doesn't tell he reader whether we agree or disagree with hese specific opinions of the experts.

best available science in concert with input from lynx experts suggests that the probability of the persistence of resident breeding populations will decline in all geographic units beginning as early as 2025, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

We conclude that the ~~potential~~ functional extirpation of resident lynx populations from one or more geographic units would demonstrate a loss of resiliency, reduced redundancy, and, possibly, reduced representation within the DPS. The~~se~~ probability of losses in resiliency, redundancy, and representation ~~will~~ puts the Canada lynx DPS at increasing risk of extirpation through the end of this century.

Comment [MJM81]: It actually starts now. All species have decreasing probability of persistence over time. That probability begins to decline immediately and never stays the same or increases.

Comment [MJM82]: It's not the potential but rather the actual extirpa ion that would demonstrate a loss of the 3Rs.

Comment [MJM83]: None of he overall conclusions helps decisionmakers understand how big the risk is. Recommend presenting our conclusions about the probabili ies of persistence.

From: Zelenak, Jim
To: Parkin, Mary
Cc: Martin Miller
Subject: Re: Talk with Marty tomorrow?
Date: Tuesday, December 06, 2016 8:05:33 AM

I've invited Justin to join us as he has also been contacted by Jodi about helping us wrap up this revision so we can get it out for peer and partner review.

On Mon, Dec 5, 2016 at 10:29 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:

> Okay, let's go for it!
>
> Marty, the call-in info is (b) (5) CIP, passcode (b) (5) CIP.
>
> Thanks,
> Mary
>
> On Mon, Dec 5, 2016 at 5:36 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Mary,
> >
> > That sounds like a good idea. I'm currently looking over Mark's attempt to address Marty's comments, and I will probably have some questions. Some he added to the unit summary for Maine in Ch. 5 - but I think it is the kind of info that would be better in the detailed unit analysis below the summary - but we can discuss that.
> >
> > The other Core Team members on Friday sent me there attempts to address Marty's context comments, but I haven't gotten beyond Mark's yet.
> >
> > I'll plan on dialing in at 12 EST, don't know Jodi's availability but will mention it if I see her in the morning (she's out of the office today at a fisher meeting I think).
> >
> > Please pass along the number and participant code to Marty - I'll dial in as leader.
> >
> > thanks! Talk to you then.
> >
> > On Mon, Dec 5, 2016 at 3:14 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:
> >
> > > Hi Jim,
> > >
> > > I just went over last Tuesday's discussion Marty, at least the part regarding his comment on the analytical context. He continues to feel that it's an important point to deal with correctly, and told me that although he's traveling the next few days, he could fit in a call tomorrow at noon Eastern to go over his thinking with you.
> > >
> > > Would you be open to that? I suggested to him that talking with you rather than the whole team might be the most efficient way to go, if that's ok -- then you could convey it further, as appropriate.
> > >
> > > I suggest a 3-way conversation at this point: you, him, and me. Or, would you want to include Jodi? Seems like it would be easier to sort through this if it doesn't become a big group discussion.
> > >
> > > If you're up for it, I could send him the conference call info you use for the lynx.
> > >
> > > Thanks,

> > Mary
> >
> > --
> > *Mary Parkin*
> > *Endangered Species Recovery Coordinator, Northeast Region*
> > *U.S. Fish and Wildlife Service, Hadley, MA*
> > *Remotely located in Escalante, Utah:*
> > *Mailing address PO Box 637, Escalante, UT 84726*
> > *Street address 145 North Center St, Escalante, UT 84726*
> > *Phone 617-417-3331*
> > *Email mary_parkin@fws.gov*
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Anthony Tur; Brad Thompson; Chris Mensing; David Stilwell; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Karl Halupka; Kate Novak; Kim Garner; Larry Crist; Laura Ragan; Leslie Ellwood; Mark Maghini; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tyler Abbott; Wally Murphy; Dennis Mackey; Patricia Zenone; Gary Miller; Karen Cathey; Steve Spangle; Tom McDowell; Anna Harris; Szymanski, Jennifer
Subject:	Internal Lynx SSA Coordination Call
Date:	Tuesday, January 10, 2017 7:29:27 AM

Hi All:

We will have a quick update/ coordination call at 10 AM Mountain Time this morning.

(b) (5) CIP
passcode: (b) (5) CIP

Thanks.
--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Seth Willey; Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Anthony Tur; Brad Thompson; Chris Mensing; David Stilwell; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Karl Halupka; Kate Novak; Kim Garner; Larry Crist; Laura Ragan; Leslie Ellwood; Mark Maghini; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tyler Abbott; Wally Murphy; Dennis Mackey; Patricia Zenone; Gary Miller; Karen Cathey; Steve Spangle; Tom McDowell; Anna Harris; Szymanski, Jennifer
Subject:	Internal Lynx SSA Coordination Call
Date:	Tuesday, January 10, 2017 9:29:30 AM

Hi All:

We will have a quick update/ coordination call at 10 AM Mountain Time this morning.

(b) (5) Commerical Information

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Shoemaker, Justin
To:	Bush, Jodi
Cc:	Jim Zelenak
Subject:	Re: Invitation: Lynx decision meeting - planning discussion @ Tue Jan 31, 2017 8:15am - 9am (jodi_bush@fws.gov)
Date:	Wednesday, January 25, 2017 7:36:49 AM

That should be fine Jodi. I'm mainly hoping to discuss RD expectations, who's doing what at the meeting, what we should be working on to get ready, who is invited, securing a room.

Justin Shoemaker
Senior Listing Biologist
U.S. Fish and Wildlife Service, Region 6
1511 47th Avenue, Moline, IL 61265
Phone: 309-757-5800 ext. 214
Email: justin_shoemaker@fws.gov

On Tue, Jan 24, 2017 at 3:10 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> I've got a state DNRC meeting at 9am and I'll have to leave for it a few minutes early -like 845. Is a half hour enough time? I guess I'll assume that you can carry on call without me.
> JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Tue, Jan 24, 2017 at 1:36 PM, Justin Shoemaker <justin_shoemaker@fws.gov> wrote:
>
> **Lynx decision meeting - planning discussion** more details »
>
> 877-357-9157 Participant #32153955 Leader #38322013
>
> When Tue Jan 31, 2017 8:15am – 9am Mountain Time
>
> Where (b) (5) CIP Participant (b) (5) CIP Leader (b) (5) CIP (map)
>
> Video call https://plus.google.com/hangouts/_/doi.gov/justin-shoemake
>
> Calendar jodi_bush@fws.gov
>
> Who
> - justin_shoemaker@fws.gov - organizer
> - marjorie_nelson@fws.gov
> - craig_hansen@fws.gov
> - jodi_bush@fws.gov
> - jim_zelenak@fws.gov
> - sarah_backsen@fws.gov
> - jennifer_szymanski@fws.gov
>
> Going? Yes - Maybe - No more options »
>
> Invitation from Google Calendar

You are receiving this email at the account jodi_bush@fws.gov because you are subscr bed for invitations on calendar jodi_bush@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Cc:	Mary Parkin; Heather Bell; Justin Shoemaker; Jonathan Cummings; Jodi Bush
Subject:	Lynx SSA Core Team Call
Date:	Monday, January 30, 2017 4:55:15 PM

Hi All:

I thought it would be helpful for the Core Team to have a quick call tomorrow at our usual time, 10:00 AM Mountain Time. I will provide a few updates and also welcome any topics you all would like to discuss.

FIT and Management Teams are also welcome if they care to attend.

(b) (5)
Commerical
Information

Thanks,

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Szymanski, Jennifer
Subject: Re: Invitation: Lynx SSA Call @ Fri Feb 3, 2017 9am - 10am (jennifer_szymanski@fws.gov)
Date: Thursday, February 02, 2017 8:27:09 AM

It's no bother Jennifer - I probably put it in the wrong section of the invite.

On the powerpoint I sent - it was not intended to be what will be used at the decision meeting - just a template with some background. I suspect we would provide more detailed analyses for each unit - current conditons summaries, expert predictions of persistence for each, and the reasons, if any, why core team reached different conclusions.

We can talk details tomorrow. I will forward you an email from Mark that highlights some of his concerns/questions - he will want to discuss these tomorrow as well - and my general responses.

On Thu, Feb 2, 2017 at 8:05 AM, Szymanski, Jennifer <jennifer_szymanski@fws.gov> wrote:

> Now, I see it. Sorry to bother you!
>
> On Thu, Feb 2, 2017 at 8:39 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > It should have been included on the calendar invitation - it shows in mine in the "Description" part of the invite. Anyway:
> >
> > (b) (5) CIP
> > passcode: (b) (5) CIP
> >
> > On Thu, Feb 2, 2017 at 6:02 AM, Szymanski, Jennifer <jennifer_szymanski@fws.gov> wrote:
> >
> > > Hi Jim,
> > >
> > > Do you have conf. line? Or, we can use mine, but you'll need to update the invite (I cannot modify it).
> > >
> > > Telephone: (b) (5) CIP ; passcode: (b) (5) CIP
> > >
> > > Jennifer
> > >
> > > On Wed, Feb 1, 2017 at 4:57 PM, Jim Zelenak <jim_zelenak@fws.gov> wrote:
> > >
> > > > **Lynx SSA Call** **more details »**
> > > >
> > > > (b) (5) CIP
> > > > passcode: (b) (5) CIP
> > > >
> > > > 10 AM Eastern; 9 AM Central; 8 AM Mountain; 7 AM Pacific Time.
> > > >
> > > > When Fri Feb 3, 2017 9am – 10am Central Time
> > > > Where Small Conference Room. (map)
> > > > Video call https://plus.google.com/hangouts/_/doi.gov/doi-gov-adn99iu
> > > > Calendar jennifer_szymanski@fws.gov
> > > > Who
> > > > - jim_zelenak@fws.gov - creator
> > > > - tamara_smith@fws.gov

- bryon_holt@fws.gov
- jodi_bush@fws.gov
- justin_shoemaker@fws.gov
- jwcummings@usgs.gov
- mark_mccollough@fws.gov
- heather_bell@fws.gov
- jennifer_szymanski@fws.gov
- kurt_broderdorp@fws.gov
- mary_parkin@fws.gov

Going? **Yes** - **Maybe** - **No** more options »

Invitation from Google Calendar

You are receiving this email at the account jennifer_szymanski@fws.gov because you are subscribed for invitations on calendar jennifer_szymanski@fws.gov.

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Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

--

Jennifer Szymanski
U.S. Fish and Wildlife Service
Division of Endangered Species
Remotely located at:
U.S. Fish and Wildlife Service Resource Center
555 Lester Avenue
Onalaska, WI 54650
Tel: 608-783-8455; Fax: 608-783-8450
Cell: 608-799-3899
jennifer_szymanski@fws.gov
***My work schedule is: M, W, Th 6:30 -4:30pm;
T&F: 8:00-1:00pm (telework: 608-799-3899)

--

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--

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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: McCollough, Mark
Subject: Re: Lynx Decision Meeting Needs
Date: Thursday, February 02, 2017 9:34:01 AM

I'd wait until we talk to Jennifer tomorrow before starting on a powerpoint or summary. I'm not sure that time will be allotted for all Core Team members to provide their own presentation, and I'm not certain that Jennifer or decision makers expect a 2-3 page summary of each geographic unit from each team member or if the 2-3 (4?)-pg. summary is expected for the entire DPS. Let's get clarity on those things on the call tomorrow. I suspect it will be a single powerpoint that I will present that will include information provided by the core team for the individual units - or perhaps a presentation we give as a team, switching presenters for each unit?

Feel free also on the call tomorrow to ask Jennifer about her experience at other decision meetings regarding listing recommendations from biologists/core teams.

Call-in number should have been included on the calendar invitation; regardless, it is our usual number:

(b) (5)
Commerical
Information

Jim

On Thu, Feb 2, 2017 at 5:49 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Jim: Thanks for arranging this meeting. I will be able to be on the call. Call in number?
>
> My time is very tight between now and March 2, so I would like to get started on my power point and 2-3 page unit summary for the Decision Team meeting. My question for Jennifer is whether there is a suggested outline for these and/or what key topics should be addressed. She they address listing and listing factors, an overall summary of unit (which is already done in the SSA), or something else? (I haven't had a chance yet to read through the docs you sent yesterday, so maybe the answers are there.)
>
> Will discuss a listing recommendation from the team in tomorrow's meeting?
>
> Mark
>
> On Wed, Feb 1, 2017 at 5:49 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi All:
> >
> > On the Core Team call yesterday I agreed to try to arrange (via doodle poll) a time for us to talk with Jennifer regarding preparations/tasks for the decision meeting in Denver in early March. However, because of Jennifer's tightly-packed schedule, I've instead coordinated with her on a call time that works for her.
> >
> > I will send a calendar invitation shortly for that call, to be held this Friday, Feb. 3, at 9:00 AM **Central Time**.
> >
> > Because the call will include discussion of the role of the Core Team at the decision meeting, I request that all Core Team members make it a priority to be on the call and to have questions ready for Jennifer.
> >
> > Thanks,
> >
> > Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED

Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Szymanski, Jennifer
Subject: Re: Invitation: Lynx SSA Team Call @ Tue Feb 7, 2017 11am - 12pm (jennifer_szymanski@fws.gov)
Date: Tuesday, February 07, 2017 9:58:08 AM

No, not specifically right now. If later, I'll be in touch.

thanks

On Tue, Feb 7, 2017 at 9:55 AM, Szymanski, Jennifer <jennifer_szymanski@fws.gov> wrote:

> Sorry, Jim. I am tied up with massasauga today. Do you have specific questions/concerns for me?

On Tue, Feb 7, 2017 at 10:30 AM, Jim Zelenak <jim_zelenak@fws.gov> wrote:

> **Lynx SSA Team Call** **more details »**
>
> (b) (5) CIP
> Pass code (b) (5) CIP
>
> When Tue Feb 7, 2017 11am – 12pm Central Time
>
> Where Small Conference Room (map)
>
> Video call https://plus.google.com/hangouts/_/doi.gov/doi-gov-adn99iu
>
> Calendar jennifer_szymanski@fws.gov
>
> Who
> - jim_zelenak@fws.gov - creator
> - mary_parkin@fws.gov
> - heather_bell@fws.gov
> - justin_shoemaker@fws.gov
> - jodi_bush@fws.gov
> - kurt_broderdorp@fws.gov
> - tamara_smith@fws.gov
> - mark_mccollough@fws.gov
> - bryon_holt@fws.gov
> - jwcummings@usgs.gov - optional
> - jennifer_szymanski@fws.gov - optional
>
> Your attendance is **optional**.
>
> Going? **Yes** - **Maybe** - **No** more options »
>
> Invitation from Google Calendar
>
> You are receiving this email at the account jennifer_szymanski@fws.gov because you are subscribed for invitations on calendar jennifer_szymanski@fws.gov.
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--
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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Nelson, Marjorie
Subject: Re: Invitation: Lynx call @ Mon Feb 13, 2017 12pm - 1pm (jodi_bush@fws.gov)
Date: Wednesday, February 08, 2017 8:56:19 AM

I'm going to be hard to get ahold of next week. Presume it will go ahead without me. Perhaps you can give me a run down afterwards vie email since Jim is not on these calls (should he be?). JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Wed, Feb 8, 2017 at 8:54 AM, Nelson, Marjorie <marjorie_nelson@fws.gov> wrote:

> The ARDs that are coming wanted to know what to expect. We need to get that same message to the core team. I'll talk to Jennifer and Justin about another planning call. I assume to invite you.

Marjorie Nelson
Chief, Division of Ecological Services
Mountain-Prairie Region
U.S. Fish and Wildlife Service
303-236-4258

On Wed, Feb 8, 2017 at 8:12 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Do you know what this is about? JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> ---------- Forwarded message ----------
> From: **Paul Phifer** <paul_phifer@fws.gov>
> Date: Wed, Feb 8, 2017 at 8:07 AM
> Subject: Invitation: Lynx call @ Mon Feb 13, 2017 12pm - 1pm (jodi_bush@fws.gov)
> To: jodi_bush@fws.gov, rollie_white@fws.gov, michael_thabault@fws.gov, martin_miller@fws.gov, lori_nordstrom@fws.gov, justin_shoemaker@fws.gov, deborah_riley@fws.gov, jennifer_szymanski@fws.gov, marjorie_nelson@fws.gov
>
> **Lynx call** **more details »**
>
> When Mon Feb 13, 2017 12pm – 1pm Mountain Time

Where	(b) (5) CIP map)
Video call	https://plus.google.com/hangouts/_/doi.gov/paul-phifer
Calendar	jodi_bush@fws.gov
Who	• paul_phifer@fws.gov - organizer • rollie_white@fws.gov • michael_thabault@fws.gov • martin_miller@fws.gov • lori_nordstrom@fws.gov • justin_shoemaker@fws.gov • deborah_riley@fws.gov • jennifer_szymanski@fws.gov • jodi_bush@fws.gov • marjorie_nelson@fws.gov

Going? **Yes** - **Maybe** - **No** more options »

Invitation from Google Calendar

You are receiving this email at the account jodi_bush@fws.gov because you are subscr bed for invitations on calendar jodi_bush@fws.gov.

To stop receiving these emails, please log in to https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn More.

From: Google Calendar
To: martin_miller@fws.gov; rollie_white@fws.gov; michael_thabault@fws.gov; lori_nordstrom@fws.gov; paul_phifer@fws.gov; deborah_riley@fws.gov; jennifer_szymanski@fws.gov; justin_shoemaker@fws.gov; jodi_bush@fws.gov
Subject: [Update] Lynx call
Date: Monday, February 13, 2017 12:51:33 PM

Hi all,

Based on the question from our call, we will have an SOL at the meeting to be on hand to answer any legal/policy questions. They won't have a decision-maker role.
Marj

Lynx call

When Mon Feb 13, 2017 12pm – 1pm Mountain Time

Where (b) (5) CIP (map)

Video call https://plus.google.com/hangouts/_/doi.gov/paul-phifer

Who
- paul_phifer@fws.gov - organizer
- lori_nordstrom@fws.gov
- michael_thabault@fws.gov
- jennifer_szymanski@fws.gov
- rollie_white@fws.gov
- deborah_riley@fws.gov
- justin_shoemaker@fws.gov
- marjorie_nelson@fws.gov
- jodi_bush@fws.gov
- martin_miller@fws.gov

From: Nelson, Marjorie
To: Bush, Jodi
Subject: Re: [Update] Lynx call
Date: Monday, February 13, 2017 1:24:45 PM

I can or Justin can. We just review the overview of how the meeting will be run in light of the conversation with Noreen and Matt.

Marjorie Nelson
Chief, Division of Ecological Services
Mountain-Prairie Region
U.S. Fish and Wildlife Service
303-236-4258

On Mon, Feb 13, 2017 at 1:04 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> I would like a summary of what the call was about. Perhaps Justin can give Jim a call and chat with him since I am out of the office this week. JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Mon, Feb 13, 2017 at 12:51 PM, <marjorie_nelson@fws.gov> wrote:
>
> > Hi all,
> >
> > Based on the question from our call, we will have an SOL at the meeting to be on hand to answer any legal/policy questions. They won't have a decision-maker role.
> > Marj
> >
> > **Lynx call**
> > When Mon Feb 13, 2017 12pm – 1pm Mountain Time
> > Where (b) (5) CIP (map)
> > Video call https://plus.google.com/hangouts/_/doi.gov/paul-phifer
> > Who
> > - paul_phifer@fws.gov - organizer
> > - lori_nordstrom@fws.gov
> > - michael_thabault@fws.gov
> > - jennifer_szymanski@fws.gov
> > - rollie_white@fws.gov
> > - deborah_riley@fws.gov
> > - justin_shoemaker@fws.gov
> > - marjorie_nelson@fws.gov
> > - jodi_bush@fws.gov
> > - martin_miller@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Cc:	Mary Parkin; Heather Bell; Justin Shoemaker; Jodi Bush; Szymanski, Jennifer
Subject:	Lynx SSA Core/FIT call
Date:	Tuesday, February 14, 2017 10:37:57 AM

Hi All:

Thought we would have a quick call at the usual time/numbers today to catch up on decision meeting planning and what we've heard so far in the comments/reviews we've gotten back.

Jennifer won't be able to join, but let me know on the call if you have questions for her, and I will pass them along.

I left Jonathan off this call as I don't think we will have topics requiring his input (plus he's really busy, too).

I sent calendar invites.

10:00 AM Mountain Time
(b) (5) CIP
(b) (5) CIP

Thanks.

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Smith, Tamara
To: Nordstrom, Lori
Cc: Peter Fasbender; Laura Ragan; Shull, Alisa; Barbara Hosler; Jim Zelenak
Subject: Re: informal briefing for Lynx SSA
Date: Thursday, February 23, 2017 3:28:49 PM
Attachments: Galatowitsch_2009_Climate_Change_Adaption_Strategies_Conservation.pdf

---

Hi Lori -

To follow up on our conversation today, I asked Ron Moen to clarify this comment in the peer review - "Disappearance of suitable habitat with climate change. I am not sure that I agree with this statement. With climate change, and with a high scenario, I do believe that lynx habitat in MN would disappear (see Galatowitsch et al. 2009). Text is on 160-1++ "

He replied that he was referring to the 2060-2069 time frame in Galatowitsch et al. 2009 (attached), when they predicted the loss of the boreal forest biome in MN.

He also noted that "Their timeframe is 2060 -2069, although I can certainly see it going a little more than that, perhaps starting at 2050 but that wouldn't have a literature citation."

Thanks,
Tam

On Thu, Feb 23, 2017 at 12:09 PM, Smith, Tamara <tamara_smith@fws.gov> wrote:

> Hi All - I have attached a briefing paper for today's call. Laura has agreed to print a few copies to hand out. I'll be calling in but I believe Pete will be driving over to the RO.
>
> Please use the following call-in information.
> (b) (5) CIP
> (b) (5) CIP
>
> Thanks
> Tam
>
> On Tue, Feb 14, 2017 at 1:04 PM, Smith, Tamara <tamara_smith@fws.gov> wrote:
>
> > Hi Lori - Great! I added Jennifer to the calendar invite. Thanks!
> >
> > On Tue, Feb 14, 2017 at 12:52 PM, Nordstrom, Lori <lori_nordstrom@fws.gov> wrote:
> >
> > > Excellent, is Jennifer also going to be included? Check in with her, maybe she and I just need to have a separate conversation.
> > >
> > > I've been reading the lynx SSA and it's giving me "deja vu all over again" after spending so much of my career on these same lynx listing issues!
> > >
> > > Thanks
> > > Lori
> > >
> > > Lori H. Nordstrom
> > > Assistant Regional Director - Ecological Services

U.S. Fish and Wildlife Service, Midwest Region
5600 American Blvd. West, Suite 990
Bloomington, MN 55437
612/713-5345
Cell: 612/772-3549
lori_nordstrom@fws.gov

On Tue, Feb 14, 2017 at 12:37 PM, Smith, Tamara <tamara_smith@fws.gov> wrote:

> Hi Lori -
>
> I'd like to schedule a time for us to talk about the lynx SSA prior to the decision maker meeting scheduled for March 2nd - 3rd. I will look at our calendars and send calendar invitations.
>
> Thanks!
> Tam
>
> --
> Tamara Smith
> U.S. Fish and Wildlife Service
> Twin Cities Field Office
> 4101 American Boulevard East
> Bloomington, MN 55425
> 952-252-0092, Ext. 219 (new number)
> 952-646-2873 (new fax number)
>
> 612-600-1599 Cell

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext. 219 (new number)
952-646-2873 (new fax number)

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--
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Bloomington, MN 55425
952-252-0092, Ext. 219 (new number)
952-646-2873 (new fax number)

612-600-1599 Cell

From:	Melbihess, Tracy
To:	Rollie White; Sarah Hall; Marilet Zablan; Eric Rickerson; Paul Henson; Gregory Hughes; Cynthia Barry
Cc:	Hendricks, Kathleen; Dennis Mackey; Tracy Melbihess; Bryon Holt; Karen Cathey; Craig Rowland; Brad Thompson
Subject:	Briefing paper for Lynx SSA Discussion, 2/27/17
Date:	Friday, February 24, 2017 4:19:23 PM
Attachments:	OSC letter 2-23-17.pdf Briefing Memo on Canada lynx SSA for ARD.docx

---

Hi all,
Please see the attached briefing paper (with supplementary information) and letter from the Office of Species Conservation for our discussion Monday morning on the Canada lynx Species Status Assessment.

As per the calendar invite, please use the following teleconference number: Teleconference: (b) (5) CIP; Participant Passcode: (b) (5) CIP

Thank you,
Tracy

--

Classification and Recovery Branch Chief
Idaho Fish and Wildlife Office (IFWO), Region 1
US Fish and Wildlife Service
#208-378-5287 (office)

and temporary assignment to

Mexican Wolf Recovery Program
Southwest Regional Office, Region 2
US Fish and Wildlife Service
#208-258-0253 (cell)

From:	Holt, Bryon
To:	Gregg Kurz
Subject:	Fwd: Briefing paper for Lynx SSA Discussion, 2/27/17
Date:	Monday, February 27, 2017 10:03:01 AM
Attachments:	OSC letter 2-23-17.pdf Briefing Memo on Canada lynx SSA for ARD.docx

---

FYI

---------- Forwarded message ----------
From: **Melbihess, Tracy** <tracy_melbihess@fws.gov>
Date: Fri, Feb 24, 2017 at 3:19 PM
Subject: Briefing paper for Lynx SSA Discussion, 2/27/17
To: Rollie White <rollie_white@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Eric Rickerson <eric_rickerson@fws.gov>, Paul Henson <paul_henson@fws.gov>, Gregory Hughes <greg_m_hughes@fws.gov>, Cynthia Barry <cynthia_barry@fws.gov>
Cc: "Hendricks, Kathleen" <kathleen_hendricks@fws.gov>, Dennis Mackey <dennis_mackey@fws.gov>, Tracy Melbihess <tracy_melbihess@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Karen Cathey <karen_cathey@fws.gov>, Craig Rowland <craig_rowland@fws.gov>, Brad Thompson <brad_thompson@fws.gov>

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Thank you,
Tracy

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#208-378-5287 (office)

and temporary assignment to

Mexican Wolf Recovery Program
Southwest Regional Office, Region 2
US Fish and Wildlife Service
#208-258-0253 (cell)

--
****
Bryon Holt
U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

From:	Rollie White
To:	jesse_delia@fws.gov
Subject:	Fwd: Briefing paper for Lynx SSA Discussion, 2/27/17
Date:	Monday, February 27, 2017 10:46:02 AM
Attachments:	Untitled attachment 16616.htm OSC letter 2-23-17.pdf Briefing Memo on Canada lynx SSA for ARD.docx Untitled attachment 16619.htm

---

This may help.

Rollie White
Assistant Regional Director - Ecological Services
Pacific Region
911 NE 11th Ave.
Portland, OR 97232
O: (503) 231-6151
M: (503) 839-2872

Rollie_White@fws.gov

Begin forwarded message:

> **From:** "Melbihess, Tracy" <tracy_melbihess@fws.gov>
> **Date:** February 24, 2017 at 3:19:17 PM PST
> **To:** Rollie White <rollie_white@fws.gov>, Sarah Hall <sarah_hall@fws.gov>, Marilet Zablan <marilet_zablan@fws.gov>, Eric Rickerson <eric_rickerson@fws.gov>, Paul Henson <paul_henson@fws.gov>, Gregory Hughes <greg_m_hughes@fws.gov>, Cynthia Barry <cynthia_barry@fws.gov>
> **Cc:** "Hendricks, Kathleen" <kathleen_hendricks@fws.gov>, Dennis Mackey <dennis_mackey@fws.gov>, Tracy Melbihess <tracy_melbihess@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Karen Cathey <karen_cathey@fws.gov>, Craig Rowland <craig_rowland@fws.gov>, Brad Thompson <brad_thompson@fws.gov>
> **Subject: Briefing paper for Lynx SSA Discussion, 2/27/17**
>
> Hi all,
> Please see the attached briefing paper (with supplementary information) and letter from the Office of Species Conservation for our discussion Monday morning on the Canada lynx Species Status Assessment.
>
> As per the calendar invite, please use the following teleconference number: Teleconference: (b) (5) CIP; Participant Passcode: (b) (5) CIP
>
> Thank you,
> Tracy
>
> --
>
> Classification and Recovery Branch Chief

Idaho Fish and Wildlife Office (IFWO), Region 1
US Fish and Wildlife Service
#208-378-5287 (office)

and temporary assignment to

Mexican Wolf Recovery Program
Southwest Regional Office, Region 2
US Fish and Wildlife Service
#208-258-0253 (cell)

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Heather Bell; Mary Parkin; Justin Shoemaker; Jonathan Cummings
Cc:	Jodi Bush
Subject:	Lynx Core/FIT Teams call
Date:	Monday, March 06, 2017 5:44:38 PM

Hi Teams:

In a few minutes I will send a message cancelling the larger monthly internal FWS lynx SSA coordination call with a note that a final recommendation has not been made and that we still have some work to do to digest and adequately consider the late peer review comments we received before a recommendation can be finalized.

However, I'm hoping that most of you can attend a Core/FIT Teams call tomorrow at the usual time/number so we can discuss the meeting last week and ensure we are all on the same page moving forward. You should have received a Google invitation,but just in case:

(b) (5) Commerical Information

Talk to you then.

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Heather Bell; Mary Parkin; Justin Shoemaker; Jonathan Cummings
Cc:	Jodi Bush
Subject:	Lynx Core/FIT Teams call
Date:	Monday, March 06, 2017 5:44:38 PM

Hi Teams:

In a few minutes I will send a message cancelling the larger monthly internal FWS lynx SSA coordination call with a note that a final recommendation has not been made and that we still have some work to do to digest and adequately consider the late peer review comments we received before a recommendation can be finalized.

However, I'm hoping that most of you can attend a Core/FIT Teams call tomorrow at the usual time/number so we can discuss the meeting last week and ensure we are all on the same page moving forward. You should have received a Google invitation,but just in case:

10:00 AM Mountain Time
(b) (5) CIP
Participant passcode: (b) (5) CIP

Talk to you then.

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Holt, Bryon
To:	Zelenak, Jim
Subject:	Re: Summary of Peer Review and State Comments -Lynx SSA
Date:	Thursday, March 16, 2017 4:21:57 PM
Attachments:	2017 03 13 Summary of Peer and State review comments_Bryon"s cmmts_3-15-17.docx

Jim,

Here is what I was able to get completed. I'm off tomorrow, back on Monday.

Bryon

On Mon, Mar 13, 2017 at 3:27 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Team,
>
> Our first assignment was to more thoroughly review late peer reviews and get back to DMs regarding whether any reviews might suggest major inadequacies or substantial changes in the SSA report or alter our conclusions in it.
>
> I started a summary sheet for major peer review comments/concerns/themes but then decided it would be good to do the same for State comments. Please see the attached, which identifies tasks for individual team members - which peer and state reviews to summarize.
>
> Jodi would like us to have a bulleted list of the major issues identified by the end of this week, and this format should help with that (or maybe just be the list?). I've addressed Squires' major points, perhaps in more detail than is needed for this. When you add yours, you don't need to go into that level of detailed response (for now, though it may be most efficient to just get it over with....?).
>
> So, please try to add your summaries of most important peer and state review comments to the attached and plan on having in back to me by COB Thursday if possible.
>
> We can discuss on our call tomorrow - same time and number:
>
> 10 AM Mountain Time
> (b) (5) CIP
> passcode: (b) (5) CIP
>
> Hope to talk to you all then.
>
> Jim
>
> --
> Jim Zelenak, Biologist
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> 585 Shepard Way, Suite 1
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> jim_zelenak@fws.gov

--

****

Bryon Holt
U.S. Fish and Wildlife Service
Northern Idaho Field Office, Spokane, WA
Telephone: (509) 893-8014
Fax: (509) 891-6748
email: bryon_holt@fws.gov

****

From:	Zelenak, Jim
To:	Jodi Bush
Subject:	Fwd: Summary of Peer Review and State Comments -Lynx SSA
Date:	Friday, March 31, 2017 9:28:53 AM
Attachments:	2017 03 13 Summary of Peer and State review comments.docx

---

Here's what I asked them, to do, with an early draft/template attached. It is not very explicit, though I did encourage them to minimize the level of detail in responses. In the end, in the doc I sent you and Justin before I left, I did not include responses, though I did leave in some clarifying notes in some of the comments.

Part of the issue is that Mark had already been working on his responses to State of Maine comments, so he included those often very detailed responses in what he submitted to me, which I then needed to boil down into the main issues/points in the doc I sent you and Justin.

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Mon, Mar 13, 2017 at 4:27 PM
Subject: Summary of Peer Review and State Comments -Lynx SSA
To: Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>

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Jim

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jim_zelenak@fws.gov

From: Harris, Anna
To: Bush, Jodi
Subject: Re: Summary of Peer Review and State Comments -Lynx SSA
Date: Sunday, April 02, 2017 5:39:50 PM

Thank You Jodi!
Very helpful - I hope you and Jim were able to enjoy some time off last week,

On Fri, Mar 31, 2017 at 11:31 AM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> Anna. Here is the email Jim sent out as the assignment. I dont know if its clear enough but it is what we have. JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> ---------- Forwarded message ----------
> From: **Zelenak, Jim** <jim_zelenak@fws.gov>
> Date: Mon, Mar 13, 2017 at 4:27 PM
> Subject: Summary of Peer Review and State Comments -Lynx SSA
> To: Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>
>
> Hi Team,
>
> Our first assignment was to more **thoroughly review late peer reviews and get back to DMs regarding whether any reviews might suggest major inadequacies or substantial changes in the SSA report or alter our conclusions in it.**
>
> I started a summary sheet for major peer review comments/concerns/themes but then decided it would be good to do the same for State comments. Please see the attached, which identifies tasks for individual team members - which peer and state reviews to summarize.
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> Jodi would like us to have a bulleted list of the major issues identified by the end of this week, and this format should help with that (or maybe just be the list?). I've addressed Squires' major points, perhaps in more detail than is needed for this. When you add yours, you don't need to go into that level of detailed response (for now, though it may be most efficient to just get it over with....?).
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--
Anna Harris
ES Project Leader
Maine Field Office
Maine Fish and Wildlife Service Complex
(207) 902-1567
(207) 949-0561 (cell)

Maine Fish and Wildlife Service Complex

From: Shoemaker, Justin
To: Zelenak, Jim
Subject: Re: Lynx SSA Core Team Call
Date: Wednesday, April 05, 2017 4:26:00 PM

I'm out that day, but Marj is free for your proposed time.

I'd suggest a calendar invite once you settle on a day and time.

Justin Shoemaker
Acting Branch Chief for Classification and Recovery
U.S. Fish and Wildlife Service, Region 6
Phone: 303-236-4217
Email: justin_shoemaker@fws.gov

On Wed, Apr 5, 2017 at 4:12 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All,
>
> I'd like to have a Core Team call next Tuesday, April 11, at the usual time (10 AM Mountain Time) and numbers ((b) (5) CIP, passcode: (b) (5) CIP).
>
> I'd also like Core Team to try to arrange to have their immediate supervisor join us on the call so we can discuss next steps, time line, work load expectations, etc., so we are sure we are all on the same page moving forward.
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> Please let me know ASAP if the date or time absolutely doesn't work for your supervisor, and we will work to find a better time if needed.
>
> Thanks!
>
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> Montana Ecological Services Office
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> Helena, MT 59601
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> jim_zelenak@fws.gov

From: Smith, Tamara
To: Zelenak, Jim
Cc: Mark McCollough; Bryon Holt; Kurt Broderdorp; Jodi Bush; Justin Shoemaker
Subject: Re: Lynx SSA Core Team Call
Date: Thursday, April 06, 2017 9:11:36 AM

Hi Jim - That date/time works for me and looking at Pete's calendar, it seems he is free at that time also. I sent him a calendar invite. Thanks! - Tam

On Wed, Apr 5, 2017 at 5:12 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All,
>
> I'd like to have a Core Team call next Tuesday, April 11, at the usual time (10 AM Mountain Time) and numbers (b) (5) Commerical Information
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Tamara Smith
U.S. Fish and Wildlife Service
Minnesota-Wisconsin Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext. 201
952-646-2873

612-600-1599 Cell

From: Harris, Anna
To: McCollough, Mark
Subject: Re: Lynx SSA Core Team Call
Date: Thursday, April 06, 2017 9:42:55 AM

Great,

Thanks for checking Mark-

On Thu, Apr 6, 2017 at 9:40 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> 12:00 to 1:00 would be better for me too given my schedule next Tuesday. I will ask Jim.
>
> On Thu, Apr 6, 2017 at 9:38 AM, Harris, Anna <anna_harris@fws.gov> wrote:
>
> > If we could move the call back to 12-1 I could make it.. I've got a meeting scheduled from 10:30 until 11:30 on the 11th.
> >
> > Thanks Mark,
> >
> > On Thu, Apr 6, 2017 at 8:17 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
> >
> > > Anna: Note below that R6 is having a conference call next Tuesday at noon eastern time for lynx SSA core team members and their supervisors. I hope you can make it. If not, then I can share the information on timeline, etc. and/or you could speak with Jodi at a later time.
> > >
> > > I heard for the first time yesterday on the call that the Lynx SSA will be completed by the end of May. That seems aggressive and provides little time, but it is up to R6 to determine how much more effort they want to put into the SSA.
> > >
> > > Mark
> > > ---------- Forwarded message ----------
> > > From: **Zelenak, Jim** <jim_zelenak@fws.gov>
> > > Date: Wed, Apr 5, 2017 at 6:12 PM
> > > Subject: Lynx SSA Core Team Call
> > > To: Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>
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--
PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED

Mark McCollough, Ph.D.
Endangered Species Specialist
US Fish and Wildlife Service
Maine Fish and Wildlife Service Complex
Ecological Services
Maine Field Office
P.O. Box A (mailing address)
306 Hatchery Road (physical address)
East Orland, Maine 04431
Telephone: (207) 902-1570
Fax: (207) 902-1588
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

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Maine Fish and Wildlife Service Complex

From: Smith, Tamara
To: Peter Fasbender
Subject: Fwd: Lynx SSA Core Team Call
Date: Thursday, April 06, 2017 8:11:18 AM

---

fyi - I just sent you a calendar invite.
---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Wed, Apr 5, 2017 at 5:12 PM
Subject: Lynx SSA Core Team Call
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From:	Smith, Tamara
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Cc:	Mark McCollough; Bryon Holt; Kurt Broderdorp; Jodi Bush; Justin Shoemaker
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Date:	Thursday, April 06, 2017 9:11:36 AM

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> > > Date: Wed, Apr 5, 2017 at 6:12 PM
> > > Subject: Lynx SSA Core Team Call
> > > To: Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>
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From: Zelenak, Jim
To: Holt, Bryon
Subject: Re: Lynx SSA Core Team Call
Date: Thursday, April 06, 2017 10:08:31 AM

That might be OK. You'll probably see a calendar invite from Jodi soon that will include Karen but also Kathleen Hendricks (?).

On Thu, Apr 6, 2017 at 8:26 AM, Holt, Bryon <bryon_holt@fws.gov> wrote:

> Jim,
>
> I read Karen's calendar wrong. She will be out of the office on that day at training.
>
> Bryon
>
> ---------- Forwarded message ----------
> From: **Holt, Bryon** <bryon_holt@fws.gov>
> Date: Thu, Apr 6, 2017 at 7:22 AM
> Subject: Re: Lynx SSA Core Team Call
> To: "Zelenak, Jim" <jim_zelenak@fws.gov>
>
> Works for me and Karen.
>
> On Wed, Apr 5, 2017 at 3:12 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
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>
> --
> **********

Bryon Holt
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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Jodi Bush
Subject: Fwd: Lynx SSA Core Team Call
Date: Thursday, April 06, 2017 10:16:43 AM

As we discussed, you will send calendar invites to Core Team and Supervisors for conference call next Tuesday, April 11, at 10:00 AM Mountain Time.

(b) (5) CIP
Participant passcode (b) (5) CIP

Recipients:

Mark McCollough and Anna Harris
Tam Smith and Peter Fasbender
Bryon Holt, Karen Cathey (and Kathleen Hendrix [spelling?])
Kurt Broderdorp and Anne Timberman

Justin?
Marj?

Vaguely recall that we decided decision team not needed on this call - is that your recollection, too? If not, and if you feel they should also be on, feel free to invite (Mike Thabault, Rollie White, Lori Nordstrom, Paul Phifer).

Thanks

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Wed, Apr 5, 2017 at 4:12 PM
Subject: Lynx SSA Core Team Call
To: Mark McCollough <mark_mccollough@fws.gov>, Tamara Smith <tamara_smith@fws.gov>, Bryon Holt <bryon_holt@fws.gov>, Kurt Broderdorp <kurt_broderdorp@fws.gov>
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U.S. Fish and Wildlife Service
Montana Ecological Services Office

585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp
Cc:	Jodi Bush; Justin Shoemaker
Subject:	Core Team Call Tomorrow
Date:	Monday, May 01, 2017 3:36:54 PM

I'd like to have a quick (I know, I know...) Core Team call to touch base on several items - comment/response spreadsheet, lit. cited, upcoming schedule for finishing the final report and the call/webinar scheduled for May 12 with the recommendation/decision team.

Hope you can make the call.

Info, in case google invitation did not get through:

(b) (5) CIP
passcode - (b) (5) CIP

Thanks.

--

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Bush, Jodi
To:	Noreen Walsh; Lori Nordstrom; rollie_white@fws.gov; Thabault, Michael; Paul Phifer; Matt Hogan; Anna Munoz
Cc:	Marjorie Nelson; Justin Shoemaker; Jim Zelenak; Jennifer Szymanski
Subject:	Lynx Webinar Information for Friday.
Date:	Thursday, May 11, 2017 1:16:30 PM
Attachments:	2017 05 12 Lynx Status Follow-up.pptx 20170505_RD Briefing Lynx SSA 2nd Status Decision Mtg.docx

Folks. Our Lynx final Decision meeting webinar is tomorrow at 1pm MTN. You all have invitations with the following information but I also wanted to provide you with hard copies of a briefing statement and the powerpoint should anything not work properly. Although we have the webinar scheduled for one hour if folks have any flex in their schedules, we may go a little longer as needed. Thank you and we will talk to you then. JB

Conf Call# (b) (5) CIP Participant # (b) (5) CIP Meeting Host: BRENT ESMOIL Join Instructions for Instant Net Conference: 1. Join the meeting now: (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP 2. Enter the required fields. 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

From: Bush, Jodi
To: Zelenak, Jim
Subject: Re: Lynx Webinar Information for Friday.
Date: Thursday, May 11, 2017 2:13:05 PM

---

yes

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Thu, May 11, 2017 at 2:04 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Also - are we in agreement that Jennifer does not need to be on the call?
>
> On Thu, May 11, 2017 at 2:00 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
>
> > I assume so . JB
> >
> > Jodi L. Bush
> > Office Supervisor
> > Montana State Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225, ext.205
> >
> > On Thu, May 11, 2017 at 1:37 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Thanks,
> > >
> > > Is that conf. number Marj's/RO's? Do we have the leader passcode, or will we assume she/they will initiate the conf. call?
> > >
> > > On Thu, May 11, 2017 at 1:16 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> > >
> > > > Folks. Our Lynx final Decision meeting webinar is tomorrow at 1pm MTN. You all have invitations with the following information but I also wanted to provide you with hard copies of a briefing statement and the powerpoint should anything not work properly. Although we have the webinar scheduled for one hour if folks have any flex in their schedules, we may go a little longer as needed. Thank you and we will talk to you then. JB
> > > > _____--
> > > >
> > > > Conf Call# (b) (5) CIP Participant # (b) (5) CIP Meeting Host: BRENT ESMOIL Join Instructions for Instant Net Conference: 1. Join the meeting now: (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP (b) (5) CIP 2. Enter the required fields. 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.

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--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
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--
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U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Szymanski, Jennifer
To: Bush, Jodi
Subject: Re: Lynx Webinar Information for Friday.
Date: Thursday, May 11, 2017 2:14:13 PM

Very good, thanks.

On Thu, May 11, 2017 at 3:12 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:

> it was just fyi. No worries. JB
>
> Jodi L. Bush
> Office Supervisor
> Montana State Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Thu, May 11, 2017 at 2:10 PM, Szymanski, Jennifer <jennifer_szymanski@fws.gov> wrote:
>
> > Hi Jody,
> >
> > I wasn't planning on attending, but if you would like me to, let me know.
> >
> > Thanks,
> > Jennifer
> >
> > On Thu, May 11, 2017 at 2:16 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
> >
> > > Folks. Our Lynx final Decision meeting webinar is tomorrow at 1pm MTN. You all have invitations with the following information but I also wanted to provide you with hard copies of a briefing statement and the powerpoint should anything not work properly. Although we have the webinar scheduled for one hour if folks have any flex in their schedules, we may go a little longer as needed. Thank you and we will talk to you then. JB
> > > _____--
> > >
> > > Conf Call#(b) (5) CIP Participant #(b) (5) CIP Meeting Host: BRENT ESMOIL Join Instructions for Instant Net Conference: 1. Join the meeting now: (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP (b) (5) CIP 2. Enter the required fields. 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.
> > >
> > > Jodi L. Bush
> > > Office Supervisor
> > > Montana State Ecological Services Office
> > > 585 Shepard Way, Suite 1
> > > Helena, MT 59601

> > (406) 449-5225, ext.205
>
> --
> *Jennifer Szymanski*
> U.S. Fish and Wildlife Service
> Division of Endangered Species
> Remotely located at:
> U.S. Fish and Wildlife Service Resource Center
> 555 Lester Avenue
> Onalaska, WI 54650
> Tel: 608-783-8455; Fax: 608-783-8450
> Cell: 608-799-3899
> jennifer_szymanski@fws.gov
> ***My work schedule is: M, W, Th 6:30 -4:30pm;
> T&F: 8:00-1:00pm (telework: 608-799-3899)

--
Jennifer Szymanski
U.S. Fish and Wildlife Service
Division of Endangered Species
Remotely located at:
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Cell: 608-799-3899
jennifer_szymanski@fws.gov
***My work schedule is: M, W, Th 6:30 -4:30pm;
T&F: 8:00-1:00pm (telework: 608-799-3899)

From:	stephanie_potter@fws.gov
To:	Lori Nordstrom; Matt Hogan; Michael Thabault; Paul Phifer; Rollie White; Marjorie Nelson; Jodi Bush; Roya Mogadam; Anna Munoz; Noreen Walsh; Jim Zelenak; Mark McCollough; Tamara Smith; Bryon Holt; Justin Shoemaker; Kurt Broderdorp
Subject:	Lynx follow up
Start:	Friday, May 12, 2017 1:00:00 PM
End:	Friday, May 12, 2017 2:00:00 PM
Location:	RD Conference room for those in the building or call in and webex info below

---

Here's the webinar and call in:

Conf Call#(b) (5) CIP Participant #(b) (5) CIP

Meeting Host: BRENT ESMOIL Join Instructions for Instant Net Conference:

1. Join the meeting now:(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP
2. Enter the required fields.
3. Indicate that you have read the Privacy Policy.
4. Click on Proceed.

From: Bush, Jodi
To: Noreen Walsh
Subject: Re: Lynx Webinar Information for Friday.
Date: Friday, May 12, 2017 9:31:21 AM

Understood. JB

Jodi L. Bush
Office Supervisor
Montana State Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Thu, May 11, 2017 at 4:42 PM, Noreen Walsh <noreen_walsh@fws.gov> wrote:

> Thank you Jodi, this looks very helpful. I have a good recollection of our discussions in March and so I'm most interested to have time to discuss if anything from the full analysis of peer or partner review might impact our interim recommendation. I hope we can get to that fairly quickly and also have a little time to discuss next steps. I will only be able to join for one hour.
>
> Looking forward to talking with you all,
>
> Noreen
>
> *Noreen Walsh*
>
> *Regional Director*
>
> *Mountain-Prairie Region*
>
> *U. S. Fish and Wildlife Service*
>
> *303 236 7920*
>
> **From:** Bush, Jodi [mailto:jodi_bush@fws.gov]
> **Sent:** Thursday, May 11, 2017 1:16 PM

To: Noreen Walsh; Lori Nordstrom; rollie_white@fws.gov; Thabault, Michael; Paul Phifer; Matt Hogan; Anna Munoz
Cc: Marjorie Nelson; Justin Shoemaker; Jim Zelenak; Jennifer Szymanski
Subject: Lynx Webinar Information for Friday.

Folks. Our Lynx final Decision meeting webinar is tomorrow at 1pm MTN. You all have invitations with the following information but I also wanted to provide you with hard copies of a briefing statement and the powerpoint should anything not work properly. Although we have the webinar scheduled for one hour if folks have any flex in their schedules, we may go a little longer as needed. Thank you and we will talk to you then. JB

_____--

Conf Call# (b) (5) CIP Participant #(b) (5) CIP Meeting Host: BRENT ESMOIL Join Instructions for Instant Net Conference: 1. Join the meeting now: (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP (b) (5) CIP 2. Enter the required fields. 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.

Jodi L. Bush

Office Supervisor

Montana State Ecological Services Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225, ext.205

From: McDowell, Tom
To: Zelenak, Jim
Subject: Re: Reminder: Lynx SSA Coordination Call
Date: Tuesday, October 24, 2017 5:21:56 PM

Jim,

I will not be able to attend due to a conflict. I appreciate your diligence in keeping us all informed via these meetings. I'll have to catch up.

Tom

Thomas L. McDowell, JD, MS
Manager, Listing and Recovery Division
Washington Fish and Wildlife Office
U.S. Fish and Wildlife Service
510 Desmond Dr. SE, Suite 102
Lacey, WA 98503
Office: 360-753-6046
Cell: 360-951-3756

On Tue, Oct 24, 2017 at 2:53 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> We will have a coordination call tomorrow, Wed., October 25, at 1:00 PM Mountain Time, to provide a quick update on the Lynx SSA and 5-year review, and to try to answer any questions that may arise.
>
> Call-in information:
>
> (b) (5) CIP
> Passcode (b) (5)
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	bob.broscheid@state.co.us; craig.mclaughlin@state.co.us; Jake Ivan - DNR; Odell, Eric; Moore,Virgil; Dustin Miller (dustin.miller@osc.idaho.gov); Joshua Uriarte; Sallabanks,Rex; Sam Eaton; rita.dixon@idfg.idaho.gov; Chandler.woodcock@maine.gov; Connolly, James; Vashon, Jennifer; moritzw@michigan.gov; bumpa@michigan.gov; kennedyd@michigan.gov; commissioner.dnr@state.mn.us; jim.leach@state.mn.us; Paul.Telander@state.mn.us; Baker, Richard (DNR); Erb, John D (DNR); JTubbs@mt.gov; McDonald, Ken; Inman, Bob; Jay Kolbe; seggeman@mt.gov; Baty, Ross; glenn.normandeau@wildlife.nh.gov; Ellingwood, Mark; john.kanter@wildlife.nh.gov; William.Staats@wildlife.nh.gov; Patrick.Tate@wildlife.nh.gov; alexandra.sandoval@state.nm.us; stewart.liley@state.nm.us; rick.winslow@state.nm.us; Stuart, James N., DGF; sean.murphy@state.nm.us; michael.schiavone@dec.ny.gov; doug.stang@dec.ny.gov; curt.melcher@state.or.us; derek.j.broman@state.or.us; Kimberly Hersey; director@dfw.wa.gov; cpl@dnr.wa.gov; Lewis, Jeffrey C (DFW); Maletzke, Benjamin T (DFW); kurt.thiede@wisconsin.gov; Sanjay.Olson@wisconsin.gov; Tom.Hauge@wisconsin.gov; Erin.Crain@wisconsin.gov; Owen Boyle; Roberts, Nathan M - DNR; Rossler, Shawn T - DNR; David.MacFarland@wisconsin.gov; John.White@wisconsin.gov; scott.talbot@wyo.gov; Bob Lanka; Zack Walker; Nichole Bjornlie; Susan Patla; Rick Kahn; Jackson, Scott -FS; Hanvey, Gary -FS; Tripp, Kim; Christopher Boone; Sparks, James; Jonathan Mawdsley; Kilborn, Jillian; Scott.Darling@vermont.gov; Kim.Royar@vermont.gov; Bernier, Chris; Mark.Scott@vermont.gov; Louis.Porter@vermont.gov
Cc:	Jodi Bush; Heather Bell; Mary Parkin; Jonathan Cummings; Justin Shoemaker; Bryon Holt; Kurt Broderdorp; Mark McCollough; Tamara Smith; Anna Harris; Brady McGee; Jeffrey Dillon; Lisa Solberg Schwab; Ann Timberman; Brad Thompson; Chris Mensing; David Stilwell; David Simmons; Drue DeBerry; Eric Rickerson; Grant Canterbury; Jeff Krupka; Szymanski, Jennifer; Karen Cathey; Karl Halupka; Kate Novak; Kathleen Hendricks; Larry Crist; Laura Ragan; Leslie Ellwood; Martin Miller; Megan Kosterman; Michelle Eames; Paul Casey; Paul Henson; Peter Fasbender; Rollie White; Sarah Hall; Scott Hicks; Sue Livingston; Tom Chapman; Tom McDowell; Tyler Abbott; Marjorie Nelson; Lori Nordstrom/R6/FWS/DOI; Paul Phifer; Michael Thabault; Kurz, Gregg; Steve Agius
Subject:	Reminder: Lynx SSA Coordination Call
Date:	Tuesday, October 24, 2017 5:53:57 PM

Hi All:

We will have a coordination call tomorrow, Wed., October 25, at 1:00 PM Mountain Time, to provide a quick update on the Lynx SSA and 5-year review, and to try to answer any questions that may arise.

Call-in information:

(b) (5) CIP
Passcode (b) (5)

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Shoemaker, Justin
To: Jodi Bush
Cc: marjorie_nelson@fws.gov
Subject: Re: Lynx - discuss SOL comments
Date: Friday, October 27, 2017 1:02:25 PM

That works for me.

Justin Shoemaker
Classification and Recovery Biologist
U.S. Fish and Wildlife Service, Region 6
Phone: 309-757-5800 x214
Email: justin_shoemaker@fws.gov

On Fri, Oct 27, 2017 at 2:01 PM, Jodi Bush <jodi_bush@fws.gov> wrote:

> Can we do 130?
>
> Sent from my iPhone
>
> On Oct 27, 2017, at 12:13 PM, Justin Shoemaker <justin_shoemaker@fws.gov> wrote:
>
> You have been invited to the following event.
>
> Title: Lynx - discuss SOL comments
> [redacted] Participant #[redacted] Leader [redacted]
> When: Fri Oct 27, 2017 1pm – 2pm Mountain Time
> Where: [redacted] Participant [redacted] Leader [redacted]
> Video call: https://plus.google.com/hangouts/_/doi.gov/justin-shoemake
> <https://plus.google.com/hangouts/_/doi.gov/justin-shoemake?hceid=anVzdGluX3Nob2VtYWtlckBmd3MuZ292.5pcgu9i736l4eavudj9m9fau61>
> Calendar: jodi_bush@fws.gov
> Who:
> * justin_shoemaker@fws.gov - organizer
> * jodi_bush@fws.gov
> * marjorie_nelson@fws.gov
>
> Event details:
> https://www.google.com/calendar/event?action=VIEW&eid=NXBjZ3U5aTczNmw0ZWF2dWRqOW05Zm F1NjEgam9kaV9idXNoQGZ3cy5nb3Y&tok=MjQjanVzdGluX3Nob2VtYWtlckBmd3MuZ292OTFiNzc2ZjlmMDVmZDVkNzdj ZDZmM2YxM2NmZWJhOGQzZTUzNzkwMw&ctz=America/Denver&hl=en
>
> Invitation from Google Calendar: https://www.google.com/calendar/
>
> You are receiving this email at the account jodi_bush@fws.gov because you are subscribed for invitations on calendar jodi_bush@fws.gov.
>
> To stop receiving these emails, please log in to

https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn more at https://support.google.com/calendar/answer/37135#forwarding

<meeting.ics>

From: Shoemaker, Justin
To: Jodi Bush
Cc: marjorie_nelson@fws.gov
Subject: Re: Lynx - discuss SOL comments
Date: Friday, October 27, 2017 1:02:25 PM

That works for me.

Justin Shoemaker
Classification and Recovery Biologist
U.S. Fish and Wildlife Service, Region 6
Phone: 309-757-5800 x214
Email: justin_shoemaker@fws.gov

On Fri, Oct 27, 2017 at 2:01 PM, Jodi Bush <jodi_bush@fws.gov> wrote:

> Can we do 130?
>
> Sent from my iPhone
>
> On Oct 27, 2017, at 12:13 PM, Justin Shoemaker <justin_shoemaker@fws.gov> wrote:
>
> You have been invited to the following event.
>
> Title: Lynx - discuss SOL comments
> (b) (5) Commerical Information
>
> When: Fri Oct 27, 2017 1pm – 2pm Mountain Time
> (b) (5) Commerical Information
>
> Calendar: jodi_bush@fws.gov
> Who:
> * justin_shoemaker@fws.gov - organizer
> * jodi_bush@fws.gov
> * marjorie_nelson@fws.gov
>
> Event details:
> (b) (5) Commerical Information
>
> Invitation from Google Calendar: https://www.google.com/calendar/
>
> You are receiving this email at the account jodi_bush@fws.gov because you are subscribed for invitations on calendar jodi_bush@fws.gov.
>
> To stop receiving these emails, please log in to

https://www.google.com/calendar/ and change your notification settings for this calendar.

Forwarding this invitation could allow any recipient to modify your RSVP response. Learn more at https://support.google.com/calendar/answer/37135#forwarding

<meeting.ics>

Label: "Meagan Racey Lynx SSA Emails"

Created by:meagan_racey@fws.gov

Total Messages in label:193 (37 conversations)

Created: 01-03-2018 at 07:38 AM

Conversation Contents

[Reminder] MTG w/State of Maine re: Lynx

meagan_racey@fws.gov

From:	meagan_racey@fws.gov
Sent:	Mon Nov 13 2017 10:15:08 GMT-0700 (MST)
To:	martin_miller@fws.gov, ken_elowe@fws.gov, anna_harris@fws.gov, meagan_racey@fws.gov, paul_phifer@fws.gov
Subject:	[Reminder] MTG w/State of Maine re: Lynx

Hi all, Just a reminder for our call today. I'm happy to kick it off, but I imagine that the first portion will really be between ES & IFW. Jim and Judy are expected to join.

Planning to cover:
- any technical questions on the SSA/recommendation from IFW - what does this really mean for them? Should they have a copy of the latest SSA?
- discuss outreach needs and opportunities. How can we coordinate on talking points (thinking about questions regarding trapping, population size, threat of climate change or forest management)? We have green light for step-down R5 lynx announcement - how can we coordinate with IFW (would they want to provide a quote on behalf of Maine, etc.)

Thanks!

MTG w/State of Maine re: Lynx

When	Mon Nov 13, 2017 2pm – 3pm Eastern Time
Where	ES Library - Call in: (b) (5) CIP, pass code: (b) (5) (map)
Video call	https://plus.google.com/hangouts/_/doi.gov/paul-phifer
Who	• paul_phifer@fws.gov - organizer • karen_stcyr@fws.gov - creator • anna_harris@fws.gov • martin_miller@fws.gov • ken_elowe@fws.gov • meagan_racey@fws.gov

From:	Tisler, Todd M -FS on behalf of Clark, Tyrone K -FS
To:	Hanvey, Gary -FS; Tamara_Smith@fws.gov; Pfeffer, Lois J -FS
Subject:	Canada Lynx Conservation Strategy Direction
Start:	Thursday, December 07, 2017 3:30:00 PM
End:	Thursday, December 07, 2017 4:30:00 PM
Location:	[redacted] Passcode - [redacted]

Morning Folks,
Hope this time (3:30 central time) works for everyone. Looking forward to the discussion. The conference call information is listed above.
Talk to you this afternoon.
Todd

This electronic message contains information generated by the USDA solely for the intended recipients. Any unauthorized interception of this message or the use or disclosure of the information it contains may violate the law and subject the violator to civil or criminal penalties. If you believe you have received this message in error, please notify the sender and delete the email immediately.

From:	Thabault, Michael
To:	Jodi Bush; Jim Zelenak
Subject:	Fwd: [CONFIRMED] Fri, Dec 15 at 11:00a.m. Meeting/Conference Call (Greg, Gary and Reg 6) on Canada Lynx DPS 5 year Review (Dial-in [redacted] Passcode: [redacted]) - Rm 3358
Date:	Friday, December 15, 2017 8:34:42 AM

Jodi/Jim, per my voicemail to Jodi please join the call. Both Noreen and I think it a good idea. I will still be lead for the briefing. I may throw specific questions to you but keep the answers short, on point, and not overly technical. Thanks.

Michael Thabault
Assistant Regional Director
Ecological Services
U.S. Fish and Wildlife Service
Mountain Prairie Region
303-236-4210
michael_thabault@fws.gov

---------- Forwarded message ----------
From: **Noreen Walsh** <noreen_walsh@fws.gov>
Date: Tue, Dec 12, 2017 at 7:35 AM
Subject: RE: [CONFIRMED] Fri, Dec 15 at 11:00a.m. Meeting/Conference Call (Greg, Gary and Reg 6) on Canada Lynx DPS 5 year Review (Dial-in: (b) (5) CIP Passcode: (b) (5) CIP #) - Rm 3358
To: Stephanie Potter <stephanie_potter@fws.gov>, Michael Thabault <michael_thabault@fws.gov>, Nicole Alt <nicole_alt@fws.gov>
Cc: Matt Hogan <matt_hogan@fws.gov>

Mike and Nicole,

Should we invite your counterparts from the other regions? Not changing the schedule, but inviting them to join this time?

Noreen

Noreen Walsh

Regional Director

Mountain-Prairie Region

U. S. Fish and Wildlife Service

303 236 7920

From: Stephanie Potter [mailto:stephanie_potter@fws.gov]
Sent: Tuesday, December 12, 2017 6:49 AM
To: Michael Thabault; Nicole Alt
Cc: Noreen Walsh; Matt Hogan
Subject: FW: [CONFIRMED] Fri, Dec 15 at 11:00a.m. Meeting/Conference Call (Greg, Gary and Reg 6) on Canada Lynx DPS 5 year Review (Dial-in: (b) (5) CIP Passcode: (b) (5) #) - Rm 3358

Good morning Mike and Nicole,

Please send any briefing materials to the RD office by tomorrow for final review. Once cleared by Noreen and Matt I will ask for them electronically so I can forward them to the Director's office (in keeping with Briefing Recommendations in the memo).

Thank you!

Stephanie

From: Irwin, Thomas [mailto:thomas_irwin@fws.gov]
Sent: Tuesday, December 12, 2017 6:35 AM
To: Stephanie Potter <stephanie_potter@fws.gov>
Cc: Lois Wellman <lois_wellman@fws.gov>; Roslyn Sellars <roslyn_sellars@fws.gov>
Subject: [CONFIRMED] Fri, Dec 15 at 11:00a.m. Meeting/Conference Call (Greg, Gary and Reg 6) on Canada Lynx DPS 5 year Review (Dial-in: (b) (5) CIP Passcode: (b) (5) CIP) - Rm 3358

Calendar invites have been sent.

Thanks,

Thomas



thomas_irwin@fws.gov - (202) 208-4545

FWS Office of the Director - 1849 C Street NW - Room 3356 - Washington, DC 20240

On Tue, Dec 12, 2017 at 8:30 AM, Stephanie Potter <stephanie_potter@fws.gov> wrote:

> Region 6 could make either time.
>
> Looping in Lois to look at Gary's calendar.
>
> **From:** Irwin, Thomas [mailto:thomas_irwin@fws.gov]
> **Sent:** Tuesday, December 12, 2017 5:44 AM
> **To:** Stephanie Potter <stephanie_potter@fws.gov>
> **Cc:** Roslyn Sellars <roslyn_sellars@fws.gov>
> **Subject:** Re: [SCHEDULING REQUEST] Briefing Canada Lynx 5 Year Review
>
> Greg's availability:
>
> **Fri, Dec 15**
>
> 11:00a.m. - 11:30a.m.
>
> 4:00p.m. - 4:30p.m.
>
> Thomas



thomas_irwin@fws.gov - (202) 208-4545

FWS Office of the Director - 1849 C Street NW - Room 3356 - Washington, DC 20240

On Mon, Dec 11, 2017 at 5:51 PM, Stephanie Potter <stephanie_potter@fws.gov> wrote:

> Good afternoon,
>
> We would like to schedule a briefing on the Canada Lynx DPS 5 year Review for Greg on Friday, if possible. The deadline is looming, and with the holidays and leave coming we would like to try to get it in before everyone starts going different directions, if possible.
>
> Kindest,
>
> Stephanie Potter
>
> Executive Assistant
>
> Office of the Regional Director
>
> Mountain-Prairie Region
>
> U.S. Fish and Wildlife Service
>
> 303-236-7920

From: Bell, Heather
To: Zelenak, Jim
Subject: Re: [Update] Lynx SSA Coordination Call
Date: Thursday, July 09, 2015 12:36:00 PM

---

good point, i forgot this went out to everyone. however, you still might want to have a place to store notes?
Yes, i am at (b) (6)(b) (6) today, thanks!

Heather Bell
Ecological Services HQ
Branch of Conservation Integration
SSA Framework Team Lead
Remotely Located at
134 S. Union Blvd
Lakewood, CO 80228
303-236-4514

Check it out! SSA Framework - Google Site for Staff
at https://sites.google.com/a/fws.gov/ssa/ and the REV Google Site: https://sites.google.com/a/fws.gov/rev/

On Thu, Jul 9, 2015 at 12:27 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> I know - but do we want everyone in the larger SSA group to have access to the lynx SSA drive?
>
> Sorry I missed you yesterday - do you have time for a quick call today?
>
> On Thu, Jul 9, 2015 at 12:24 PM, Bell, Heather <heather_bell@fws.gov> wrote:
>
> > Jim, jsut a gentle nudge that if you are going to use the google drive for lynx, you can put them up there and then just send people the link, or you can share directly from the google drive :-)
> > I know, hard to change habits!
> >
> > Heather Bell
> > Ecological Services HQ
> > Branch of Conservation Integration
> > SSA Framework Team Lead
> > Remotely Located at
> > 134 S. Union Blvd
> > Lakewood, CO 80228
> > 303-236-4514
> >
> > Check it out! SSA Framework - Google Site for Staff
> > at https://sites.google.com/a/fws.gov/ssa/ and the REV Google Site: https://sites.google.com/a/fws.gov/rev/
> >
> > On Wed, Jul 8, 2015 at 8:22 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Hi All:

Here are notes from yesterday's lynx SSA coordination call.

Thanks very much to Ann Belleman for drafting these.

Share with other FWS folks as needed.

Thanks,

Jim

On Tue, Jul 7, 2015 at 9:05 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi All:
>
> General agenda for today's call is:
>
> 1. Discuss coordination with States and other partners - Jodi's letter, talking points;
>
> 2. Planning for expert elicitation meeting in fall - location, venue, associated staff travel, etc.
>
> 3. Your questions/concerns.
>
> Talk to you soon.
>
> Jim
>
> On Thu, Jun 25, 2015 at 3:28 PM, <jim_zelenak@fws.gov> wrote:
>
> > Monthly Lynx SSA Coordination Call - July 7, 10-11 AM Mountain Time
> >
> > (b) (5) CIP
> > (b) (5)
> > CIP
> >
> > Webinar info to follow if needed.
> >
> > **Lynx SSA Coordination Call**
> >
> > When Tue Jul 7, 2015 10am – 11am Mountain Time
> >
> > Video call https://plus.google.com/hangouts/_/doi.gov/jim-zelenak
> >
> > Who • Jim Zelenak - organizer

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Smith, Tamara
To: Parkin, Mary
Subject: Re: time to talk about lynx SSA model?
Date: Thursday, September 17, 2015 11:05:56 AM

Oh shoot - someone else just called me that wasn't you. I'm off the line now.

On Thu, Sep 17, 2015 at 11:04 AM, Smith, Tamara <tamara_smith@fws.gov> wrote:

> Hi Mary - just to be clear - the call between us now -at 11- is not on this conf. line. Call me on my cell! (b) (6)(b) (6) .
>
> On Wed, Sep 16, 2015 at 10:57 AM, Smith, Tamara <tamara_smith@fws.gov> wrote:
>
> > call- in info for tomorrow's call at 9am CT.
> >
> > Telephone: (b) (5) CIP ; passcode: (b) (5) CIP # Webinar Information: Meeting Number: (b) (5) CIP Meeting Passcode: R3Species Meeting Host: MS JENNFER SZYMANSKI 1. Join the meeting: (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP (b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP(b) (5) CIP Enter the required fields (see above) 3. Indicate that you have read the Privacy Policy. 4. Click on Proceed.
> >
> > On Wed, Sep 16, 2015 at 10:53 AM, Smith, Tamara <tamara_smith@fws.gov> wrote:
> >
> > > Got it - yes she has. I think she has only missed one - last week's call. I'll let Jennfier know what is going on and get you the call in info.
> > >
> > > On Wed, Sep 16, 2015 at 10:49 AM, Parkin, Mary <mary_parkin@fws.gov> wrote:
> > >
> > > > Hi there,
> > > >
> > > > OK, we're set! And I'd like to sit in on your regular call if that's ok. Marty talked with me about taking on the RPBB, but Krishna and I haven't sorted things out yet and I won't have a chance to talk with her until tomorrow. Has she been on the bumblebee calls to date?
> > > >
> > > > Talk tomorrow,
> > > > Mary
> > > >
> > > > On Wed, Sep 16, 2015 at 11:40 AM, Smith, Tamara <tamara_smith@fws.gov> wrote:
> > > >
> > > > > Sounds good, Mary. I just sent you a calendar invite. By the way, we have a regular RPBB call on Thursday at 9am CT - are you interested in joining in on that?
> > > > >
> > > > > On Tue, Sep 15, 2015 at 4:50 PM, Parkin, Mary <mary_parkin@fws.gov> wrote:
> > > > >
> > > > > > Hey Tam!
> > > > > >
> > > > > > Thursday's going to be a whole lot better than tomorrow for me. I'd love to go over the lynx model together. Plus, I'd like to talk about the rusty-patch[ed?] bumblebee SSA, as this seems to be moving my way within R5 ... Krishna needs to delegate.
> > > > > >
> > > > > > Let's schedule 11 am CT on Thursday for a lynx/RPB conversation, ok?

Looking forward,
Mary

On Tue, Sep 15, 2015 at 5:40 PM, Smith, Tamara <tamara_smith@fws.gov> wrote:

> Hi Mary - Is there a time you could meet to talk about the lynx model? I haven't had a chance to look at it yet... but I have some time tomorrow (Wed) afternoon or Thursday 11-12am CT or 2-3pm CT. Let me know if one of those times work for you!
>
> Thanks,
> Tam
>
> --
> Tamara Smith
> U.S. Fish and Wildlife Service
> Twin Cities Field Office
> 4101 American Boulevard East
> Bloomington, MN 55425
> 612-725-3548 ext. 2219
> 612-600-1599 cell

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA
Remotely located in Escalante, Utah:
Mailing address PO Box 637, Escalante, UT 84726
Street address 145 North Center St, Escalante, UT 84726
Phone 617-417-3331
Email mary_parkin@fws.gov

--
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U.S. Fish and Wildlife Service
Twin Cities Field Office
4101 American Boulevard East
Bloomington, MN 55425
612-725-3548 ext. 2219
612-600-1599 cell

--
Mary Parkin
Endangered Species Recovery Coordinator, Northeast Region
U.S. Fish and Wildlife Service, Hadley, MA

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> > > *Phone 617-417-3331*
> > > *Email mary_parkin@fws.gov*
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612-600-1599 cell

From: Zelenak, Jim
To: Wilsey, Chad
Cc: Josh Lawler
Subject: Re: Lynx and climate
Date: Friday, October 09, 2015 1:28:42 PM

Thanks!

On Fri, Oct 9, 2015 at 1:26 PM, Wilsey, Chad <cwilsey@audubon.org> wrote:

> Here's a conference webex… It' probably preferred to use yours in case I'm late waking up, but here we have it if needed.
>
> Chad
>
> **Lynx Meeting**
>
> Wed, Oct 14, 2015 6:00 AM - 7:30 AM Pacific Daylight Time
>
> Please join my meeting from your computer, tablet or smartphone.
>
> https://global.gotomeeting.com/join/594344301
>
> **You can also dial in using your phone.**
>
> United States (Toll-free): (b) (5) CIP
>
> Access Code: (b) (5) CIP
>
> **From:** Zelenak, Jim [mailto:jim_zelenak@fws.gov]
> **Sent:** Friday, October 09, 2015 11:19 AM
> **To:** Josh Lawler <jlawler@uw.edu>
> **Cc:** Wilsey, Chad <cwilsey@audubon.org>
> **Subject:** Re: Lynx and climate
>
> Josh and Chad,

If 12:00 Pacific works for you both, please dial in to (b) (6) P.I.I. , pass code: (b) (6) P.I.I. .

Let me know if otherwise, Thanks.

Jim

On Fri, Oct 9, 2015 at 12:06 PM, Josh Lawler <jlawler@uw.edu> wrote:

> Hi Jim and Chad,
>
> I'm headed out on a field trip with my class shortly, but could chat at 12:00 if need be. Let me know. It sounds like you and Chad may be able to sort things out, but if you need to chat give me a call on my office phone (bellow) or cell ([redacted]) before 12:30.
>
> Thanks,
>
> Josh
>
> Joshua J. Lawler
> Denman Professor of Sustainable Resource Sciences
>
> School of Environmental and Forest Sciences
>
> University of Washington
>
> Box 352100
>
> Seattle, WA 98195
>
> phone: 206.685.4367
>
> fax: 206.685.0790
>
> http://depts.washington.edu/landecol
>
> email: jlawler@uw.edu
>
> Skype: jjlawler

Twitter: @jjjlawler

On Fri, Oct 9, 2015 at 10:05 AM, Wilsey, Chad <cwilsey@audubon.org> wrote:

> Jim,
>
> I'm available this morning at (b) (6)(b) (6) .
>
> I also have access to a conference calling service through my current position at Audubon. It's something I use regularly and it's no problem for me to set up a conference call with screen share. So, if your system doesn't work, we can use ours. Let me know.
>
> Josh and I have spoken and we are preparing to give remarks that fit into the 20 minutes guidelines that you've outlined. In the event that he's not available to chat today, I think we are ready to participate and would just need the call-in information for Wed morning.
>
> Chad
>
> **From:** Zelenak, Jim [mailto:jim_zelenak@fws.gov]
> **Sent:** Friday, October 09, 2015 8:36 AM
> **To:** Josh Lawler <jlawler@uw.edu>
> **Cc:** Wilsey, Chad <cwilsey@audubon.org>; Tamara Smith <tamara_smith@fws.gov>; Mary Parkin <mary_parkin@fws.gov>
> **Subject:** Re: Lynx and climate
>
> Hi Josh and Chad,
>
> Let me know if either or both of you are available for a quick call(s) today (hopefully before 12:30 PM Pacific time) to discuss next week's lynx workshop and your abilities to provide a remote presentation on your lynx/climate modeling work. If that doesn't work for you, I will have my cell ((b) (6)(b) (6)) with me this weekend, and on Mon. and Tues. next week once I'm in Minneapolis.

Right now, we have an hour on the agenda on Wednesday morning (8-9 AM Central Time [6-7 AM Pacific]) for 3 climate presentations (20 minutes each): 1. Lee Frelich from U. Minn. to discuss climate modeling of vegetative shifts with a focus on boreal forests/lynx habitats; 2. Alexej Siren U. Mass and DOI NE Climate Science Center, to discuss snow and lynx modeling in the northeast; and 3. You two on lynx response to modeled snow and vegetation changes in the northwest (let me know what title you would like me to give when introducing your presentation).

We believe we will have the ability to conduct a webinar/webex for your presentation (I'll forward the link and instructions Mon. or Tues.), where we could turn control of a computer over to you so you can "drive." Alternatively, in case of technical difficulty, could you please email me (and cc Tamara Smith and Mary Parkin, copied here) a copy of your presentation so we could flip thru slides while you describe over a conference line if necessary?

I'm looking forward to talking with you and seeing your work next week. I think it will be very informative to the assembled lynx researchers.

let me know if you have questions or need more information.

Cheers!

Jim

On Fri, Oct 2, 2015 at 4:24 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hi Josh,

Thanks for the call - it was good to finally get to talk through some of this with you.

As I said, we currently have Alexej Siren (U Mass. - snow) and Lee Frelich (U Minn. - boreal forest veg.) on board to attend and present at the lynx workshop (Tues. Oct 13 - Thurs. Oct. 15 in Minneapolis), though Lee has limited availability on Wed. morning.

Right now we have the climate presentation(s) scheduled for 8 AM Wed. morning (6 AM Pacific time) which I imagine could be tough in terms of a remote (webinar) presentation from your lab, but we could shuffle things around some and have you go Tues. afternoon if that would work better.

You should have received a previous email with additional info on the workshop. Let me know if you have questions and feel free to call any time if you want to talk.

Thanks again,

Jim

On Thu, Oct 1, 2015 at 5:18 PM, Josh Lawler <jlawler@uw.edu> wrote:

> Hi Jim,
>
> I just tried giving you a call on your cell -- but for some reason was unable to leave a message. I'll give you a try again tomorrow afternoon. That said, it sounds like you've got the climate modeling end of things taken care of, which is great. I'd be happy to put you in touch with Chad Wilsey (my former postdoc who did the lynx modeling)-- because he would be the best one to talk to you about his lynx model and population projections. I've cc'ed him here.
>
> And you are right, Big Sky is not at all a bad place to have a meeting.
>
> -Josh

Joshua J. Lawler
Denman Professor of Sustainable Resource Sciences

School of Environmental and Forest Sciences

University of Washington

Box 352100

Seattle, WA 98195

phone: 206.685.4367

fax: 206.685.0790

http://depts.washington.edu/landecol

email: jlawler@uw.edu

Skype: jjlawler

Twitter: @jjjlawler

On Thu, Oct 1, 2015 at 1:20 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hey Josh,
>
> My cell is (b) (6)(b) (6) (still have Alaska area code though it's been 6 years since I lived there) if you want to try an after-hours call while you are in Big Sky. I usually leave the office between 3:30 and 4 to pick my daughter up from school, but I usually have my cell nearby and would be happy to talk with you.
>
> Cheers!
>
> Jim
>
> On Wed, Sep 30, 2015 at 9:40 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > Hi Josh,

Thanks for getting back to me. Big Sky is not too a bad place for a meeting, yeah?

I'd like to talk to you about this if possible. It looks like we will have Alexej Siren from U Mass and DOI's Northeast Climate Science Center at the workshop to give a presentation on climate modeling re: snow. However, I would be interested in talking to yo about your post doc working on vegetation impacts, and the possibility of a remote presentation on that topic. We are also talking to Lee Frelich at U Minnesota.

Let me know when you could make a call after your meeting today, tomorrow or Friday.

Thanks.

Jim

On Tue, Sep 29, 2015 at 5:00 PM, Josh Lawler <jlawler@uw.edu> wrote:

> Hi Jim,
>
> I got your phone message last week and I apologize for not responding sooner. I couldn't decipher the area code in your message and so haven't been able to reach your cell phone.
>
> I won't be able to make it to Minnesota for your meeting the 13th-15th, but I might be able to present something remotely if the timing worked out and you thought I could provide something useful. It might be good to have a better idea of what you are after. I could, for instance, present projected changes in precipitation falling as snow for a few future time periods as produced by a set of GCMs. I would need to do a bit of work to pull that together, through. I also have a postdoc that has done some population modeling for lynx in the PNW, but he focussed on the potential impact of climate-driven changes in vegetation, not snowpack.

I will check in with some colleagues in the UW Climate Impacts Group to see if any of them have snowpack projections on hand that they could share -- there are likely others better suited than I am to provide you with the info your are looking for.

I'm at a meeting in Big Sky, MT through Friday, but can talk when I return to Seattle on Monday. I could potentially find a time to chat while here too - my cell phone is (b) (6)(b) (6) .

-Josh

Joshua J. Lawler
Denman Professor of Sustainable Resource Sciences

School of Environmental and Forest Sciences

University of Washington

Box 352100

Seattle, WA 98195

phone: 206.685.4367

fax: 206.685.0790

http://depts.washington.edu/landecol

email: jlawler@uw.edu

Skype: jjlawler

Twitter: @jjjlawler

--

Jim Zelenak, Biologist

U.S. Fish and Wildlife Service

Montana Ecological Services Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225 ext. 220

jim_zelenak@fws.gov

--

Jim Zelenak, Biologist

U.S. Fish and Wildlife Service

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--

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> > > jim_zelenak@fws.gov
>
> --
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--
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U.S. Fish and Wildlife Service
Montana Ecological Services Office

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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Michael Thabault
Subject: Re: AP requesting comment on judge"s order for a USFWS lynx recovery plan within next 30 days
Date: Friday, May 09, 2014 12:57:28 PM

---

thanks. JB

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Fri, May 9, 2014 at 12:55 PM, Michael Thabault <michael_thabault@fws.gov> wrote:

> Nothing yet. I will stay very high level. Still working in Service, many regions involved, lots of players, no decision yet.
>
> Michael Thabault
> Assistant Regional Director
> Ecological Services
> Mountain Prairie Region
>
> On May 9, 2014, at 12:53 PM, "Bush, Jodi" <jodi_bush@fws.gov> wrote:
>
>> so what are we saying? Inquiring minds want to know. :)
>>
>> Jodi L. Bush
>> Field Supervisor
>> Montana Ecological Services Office
>> 585 Shepard Way, Suite 1
>> Helena, MT 59601
>> (406) 449-5225, ext.205
>>
>> On Fri, May 9, 2014 at 12:43 PM, Michael Thabault <michael_thabault@fws.gov> wrote:
>>
>>> Will do thanks
>>>
>>> Michael Thabault
>>> Assistant Regional Director
>>> Ecological Services
>>> Mountain Prairie Region
>>>
>>> On May 9, 2014, at 12:39 PM, Leith Edgar <leith_edgar@fws.gov> wrote:

Mike,

Matt will be at (b) (6) at 2:30 today expecting a ring. Please let me know should you need to cancel or reschedule.

FYI: He's got your spelling & title, but I would remind him that "Michael" is your preferred usage for print.

Best,

Leith

From: Leith Edgar [mailto:leith_edgar@fws.gov]
Sent: Friday, May 09, 2014 12:35 PM
To: Michael Thabault
Cc: Marla Trollan; John Bryan; Jim Zelenak; Brent Esmoil; Jodi Bush; Justin Shoemaker
Subject: RE: AP requesting comment on judge's order for a USFWS lynx recovery plan within next 30 days

Mike,

I'll check with Matt & then confirm with you that he'll be at his phone at 2:30 today & what # is best to reach him.

Thanks,

Leith

From: Michael Thabault [mailto:michael_thabault@fws.gov]
Sent: Friday, May 09, 2014 12:05 PM
To: Leith Edgar

Cc: Marla Trollan; John Bryan; Jim Zelenak; Brent Esmoil; Jodi Bush; Justin Shoemaker
Subject: Re: AP requesting comment on judge's order for a USFWS lynx recovery plan within next 30 days

I can talk to him at 2:30. Is that ok?

Michael Thabault

Assistant Regional Director

Ecological Services

Mountain Prairie Region

On May 9, 2014, at 11:36 AM, Leith Edgar <leith_edgar@fws.gov> wrote:

> All,
>
> Matt Brown (Associated Press) has requested our comment on a judge's order re a lynx recovery plan that was rendered today. His deadline is 5pm MDT today. He would be appreciative of us providing him with a statement about how we are going to respond to the order. Please let me know whether we want to engage with Matt. Right now he has a placeholder for what we may provide him, but wants to know either way by 5.
>
> Thanks,
>
> Leith
>
> Leith Edgar
>
> *Public Affairs Specialist*
>
> *Mountain-Prairie Region*
>
> **U.S. Fish & Wildlife Service**

(303) 236-4588 – O; (303) 895-9143 – C

leith_edgar@fws.gov

From:	Bush, Jodi
To:	Jim Zelenak
Cc:	Shawn Sartorius; Brent Esmoil
Subject:	Fwd: AP requesting comment on judge"s order for a USFWS lynx recovery plan within next 30 days
Date:	Friday, May 09, 2014 12:57:49 PM

FYI

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

---------- Forwarded message ----------
From: **Michael Thabault** <michael_thabault@fws.gov>
Date: Fri, May 9, 2014 at 12:55 PM
Subject: Re: AP requesting comment on judge's order for a USFWS lynx recovery plan within next 30 days
To: "Bush, Jodi" <jodi_bush@fws.gov>

Nothing yet. I will stay very high level. Still working in Service, many regions involved, lots of players, no decision yet.

Michael Thabault
Assistant Regional Director
Ecological Services
Mountain Prairie Region

On May 9, 2014, at 12:53 PM, "Bush, Jodi" <jodi_bush@fws.gov> wrote:

> so what are we saying? Inquiring minds want to know. :)
>
> Jodi L. Bush
> Field Supervisor
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225, ext.205
>
> On Fri, May 9, 2014 at 12:43 PM, Michael Thabault <michael_thabault@fws.gov> wrote:
>> Will do thanks

Michael Thabault
Assistant Regional Director
Ecological Services
Mountain Prairie Region

On May 9, 2014, at 12:39 PM, Leith Edgar <leith_edgar@fws.gov> wrote:

> Mike,
>
> Matt will be at (b) (6) at 2:30 today expecting a ring. Please let me know should you need to cancel or reschedule.
>
> FYI: He's got your spelling & title, but I would remind him that "Michael" is your preferred usage for print.
>
> Best,
>
> Leith
>
> ---
>
> **From:** Leith Edgar [mailto:leith_edgar@fws.gov]
> **Sent:** Friday, May 09, 2014 12:35 PM
> **To:** Michael Thabault
> **Cc:** Marla Trollan; John Bryan; Jim Zelenak; Brent Esmoil; Jodi Bush; Justin Shoemaker
> **Subject:** RE: AP requesting comment on judge's order for a USFWS lynx recovery plan within next 30 days
>
> Mike,
>
> I'll check with Matt & then confirm with you that he'll be at his phone at 2:30 today & what # is best to reach him.
>
> Thanks,

Leith

From: Michael Thabault [mailto:michael_thabault@fws.gov]
Sent: Friday, May 09, 2014 12:05 PM
To: Leith Edgar
Cc: Marla Trollan; John Bryan; Jim Zelenak; Brent Esmoil; Jodi Bush; Justin Shoemaker
Subject: Re: AP requesting comment on judge's order for a USFWS lynx recovery plan within next 30 days

I can talk to him at 2:30. Is that ok?

Michael Thabault

Assistant Regional Director

Ecological Services

Mountain Prairie Region

On May 9, 2014, at 11:36 AM, Leith Edgar <leith_edgar@fws.gov> wrote:

> All,
>
> Matt Brown (Associated Press) has requested our comment on a judge's order re a lynx recovery plan that was rendered today. His deadline is 5pm MDT today. He would be appreciative of us providing him with a statement about how we are going to respond to the order. Please let me know whether we want to engage with Matt. Right now he has a placeholder for what we may provide him, but wants to know either way by 5.
>
> Thanks,
>
> Leith

Leith Edgar

Public Affairs Specialist

Mountain-Prairie Region

U.S. Fish & Wildlife Service

(303) 236-4588 – O; (303) 895-9143 – C

leith_edgar@fws.gov

From: Bud and Edie Journey
To: jim_zelenak@fws.gov
Subject: Lynx Study
Date: Sunday, January 18, 2015 11:56:49 AM

To: Jim Zelenak, U.S. Fish and Wildlife Service

Dear Mr. Zelenak,

After some difficulty finding your email address, I finally came across this at Montana Ecological Services Contacts. I hope other people wanting to comment on Lynxes in Montana are not discouraged by the task of finding you. I can't believe that the *Missoulian* had a front page article about seeking input on a lynx study without providing a link to you.

I have lived in Libby for 42 years and have had a primitive log cabin along the North Fork of the Yaak River in the Yaak since 1980. I shared ownership in a cabin across the river for several years before that. I spend one or more days (up to a week at a time) in the Yaak the year round, including the winter when I have to ski a half mile in to the cabin, dragging my supplies in a sled behind me. Further, I worked in predator and rodent control (i.e. trapper) supervised by the USFWS in the 60s in California. I'm a student of wildlife sign and have been so since I was a trapper all those years ago. So I have some knowledge of trapping and of the Yaak.

There are Lynxes in the Yaak – not lots of them, but some. I have seen a very few through the years, but I see their tracks all the time, along with tracks of many other species.

The main point I'd like to make with this email is that there is a significant new factor in Montana, in general, and in the Yaak, in particular, when it comes to reclaiming and sustaining lynx populations. That new factor is wolf trapping. In general, I have significant misgivings about trapping wolves, but I'm really really opposed to the incidental catch that goes with wolf trapping. I can tell you from experience that you can be the most conscientious trapper in the world, and you will still catch significant numbers of untargeted species. I was a professional trapper for half a decade before I went back to college. I know the reality of trapping, and I can authoritatively tell you that you may be able to somewhat minimize catching untargeted species, but you can't significantly limit your catches to wolves – or even canines – or even to predators. For example, I have caught deer, hawks, eagles, buzzards, rabbits, and other odd critters, along with dogs and cats. I have never caught a lynx, but I have caught lots of bobcats and have found them to be easier to trap than coyotes. I suspect it would be as easy or easier to catch lynxes, especially in a snowy region like the Yaak where reading sign is very easy.

Please don't suggest that trappers are reporting all the non-wolves they are catching, thenreleasing them. That's like saying that people always report finding cash they find on the sidewalk and turn it in to law enforcement people who then find the owners. We both know that's the exception, not the rule .Trappers are not reporting all their incidental catches – especially if the catches are dead or badly injured.

Since wolf trapping started two or three years ago in the Yaak, I have seen significantly fewer cat tracks during my wanderings over the snows of the Yaak. In fact, I haven't seen a lynx track

yet this winter, and I usually start seeing them as soon as the snow starts sticking. I understand that fluctuations in hare populations can affect lynx populations, but less so for bobcats, lions, and coyotes: other species that seem to be less ubiquitous this year than in previous years. Ironically, the one species that still seems to be leaving a fair number of tracks around are wolves.

So, yes, I can tell you from personal experience that there are lynxes in the Yaak. To say there are too many of them is nonsense. To say there are enough of them is not supported by the evidence. To say there are too few is more what the sign suggests – especially since wolf trapping has been reintroduced into the Yaak.

In my opinion, an attempt at lynx recovery in the Yaak is not only desirable but also imperative. Ignoring them to justify cutting down the few old-growth tree stands remaining there is ugly. Another ugly thing is to take 15 years to get around to even studying them, and it's even uglier to take an additional 5 years to make the determination of need. If you're objective, you should be able to start the recovery in a year, then spend the next four years-plus implementing the plan.

I also believe that a regular part of your job should be to keep people like me informed of your progress, like Wayne Kasworm does with grizzly bears. I think that factor has facilitated the good job he has done with grizzly recovery in this area. So, I'm asking you to establish a reporting system and put me on the list of people receiving reports on your progress.

I have very good photos of tracks made by Yaak lynxes, bobcats, mountain lions, wolverines, wolves, bears, and other species if they might be helpful.

If I sent this to the wrong person, please forward it to the right person. Thank you for your time.

Alfred E. "Bud" Journey
(b) (6)(b) (6)
(b) (6)(b) (6)
(b) (6)(b) (6)(b) (6)

From: Zelenak, Jim
To: Willey, Seth
Cc: Jodi Bush
Subject: Re: lynx status review
Date: Tuesday, January 27, 2015 11:36:19 AM

Thanks Seth - I think we're good.

On Tue, Jan 27, 2015 at 11:23 AM, Willey, Seth <seth_willey@fws.gov> wrote:

> No one in our office does these pages.
>
> Jim Z, we are required to publish a notice in the FR for 5-year reviews. This requirement is in our regulations, not the statute. Just because this review is taking a long time is not, in my opinion, grounds for a new FR notice. I'm not aware that we have ever done that (and we have other reviews that have taken a while - Topeka shiner took ~5 years; so did bull trout; etc). In my opinion, a new FR notice is not necessary. Furthermore, a new FR notice would take 3 or 4 months to clear, which is not something we have time for. Finally, these are not final agency actions - case law says they can not be litigated on a five year review, so very little risk.
>
> I would respond with something like "This recent announcement is a continuation of the yet to be completed 2007 status review. While we have requested information within the next several weeks, as stated in the 2007 notice, 'we will continue to accept new information about any listed species at any time'."
>
> [as background, this is not a formal public comment period, per APA, so there the beginning and end dates are really just suggestions anyways]
>
> Give me a call if you want to discuss ((b) (6) today)
>
> Seth
>
> **********
> Seth L. Willey, Acting Field Supervisor
> Colorado Ecological Services Office
> USFWS, Mountain-Prairie Region
> Seth_Willey@fws.gov
> phone: 303-236-4774
> **********
>
> On Tue, Jan 27, 2015 at 11:11 AM, Ryan Moehring <ryan_moehring@fws.gov> wrote:
>
> > That shouldn't be a problem, Jim.
> >
> > Jim Renne,
> >
> > Are you now updating those ES pages? I know Kris Olson used to do that, but I'm not sure if she was ever replaced…

-Ryan

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, January 27, 2015 11:10 AM
To: Ryan Moehring
Cc: Seth Willey; Jodi Bush; Jim Renne
Subject: Re: lynx status review

Great - can we also get it on the R6 lynx webpage? I think that is where Arlene looked and found only the 2007 FR notice. Thanks.

On Tue, Jan 27, 2015 at 11:07 AM, Ryan Moehring <ryan_moehring@fws.gov> wrote:

Jim,

Here is the link to the recent lynx NR: http://www.fws.gov/mountain-prairie/pressrel/2015/01132015_ServiceConductingFiveYearReviewCanadaLynx.php.

I'm copying Jim to see if he can help us get a link to that NR posted to the ECOS link you provided.

Thanks,

-Ryan

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, January 27, 2015 11:05 AM
To: Seth Willey
Cc: Jodi Bush; Ryan Moehring
Subject: Fwd: lynx status review

Seth,

As we discussed yesterday, I understand you made the call that because we published a notice in the FR in 2007 announcing initiation of the 5-year review for lynx that we do not need to publish another one now. Below we have a request to do so. Does that change anything, or can I just reply again in accordance with your message yesterday that the current review is a continuation of the review announced in 2007 but not yet completed?

I have had other requests for clarification of the process, and I can respond in kind to this one along with a note that the Service has determined that an FR notice is not necessary now (unless a request for a notice like that below requires a more formal response - let me know).

Ryan - could you please see that the recent news release for the 5-year review is uploaded to our R6 lynx web page (https://www.fws.gov/mountain-prairie/species/mammals/lynx/5yearreview.htm)? Or let me know who to contact to make that happen? Also - should we ask that the news release be posted under the "Recovery" heading at the species profile (national) web site (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A073)? Thanks.

Jim

---------- Forwarded message ----------
From: <arlene@wildswan.org>
Date: Tue, Jan 27, 2015 at 10:32 AM
Subject: lynx status review
To: Jim_Zelenak@fws.gov

Hello Jim
Could you please clarify the five year status review for lynx. There was a news article about the status review but there is no information on the FWS webpage other than the 2007 federal register notice. I am on the e-mail list for FWS activities yet I did not receive anything. You have only given the public 2 weeks to comment on this very important issue that was not widely distributed. I request that you extend the comment deadline and initiate an official public notice.
--
Arlene Montgomery, Program Director
Friends of the Wild Swan

P.O. Box 103
Bigfork, MT 59911
arlene@wildswan.org

--

Jim Zelenak, Biologist

U.S. Fish and Wildlife Service

Montana Ecological Services Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225 ext. 220

jim_zelenak@fws.gov

--

Jim Zelenak, Biologist

U.S. Fish and Wildlife Service

Montana Ecological Services Office

585 Shepard Way, Suite 1

Helena, MT 59601

(406) 449-5225 ext. 220

jim_zelenak@fws.gov

--

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service

Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Zelenak, Jim
To: Mark McCollough
Cc: Laury Zicari
Subject: Lynx 5-year review letter from ME
Date: Wednesday, January 28, 2015 8:15:56 AM
Attachments: 2015 01 19 LTR G Trifaro Wells ME.pdf

FYI

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

January 19, 2015

Grace J. Trifaro
(b) (6)

US Fish and Wildlife Service
Tim Zelenak

Dear Mr. Zelenak,

I am writing in regards to the issue involving de-listing the Canadian Lynx in Maine from the Status of "Endangered Species." Please DO NOT de-list these incredible wild cats!!! They do not thrive as well as the Dept of Inland fisheries and wildlife of Maine say. The DIFW would like all predators de-listed if they could because they are →

influenced by the

Maine Trappers association which loves to torture and kill as many animals as they can with their traps!! From black bear, to coyote and now the majestic Lynx, these cold-hearted individuals thrive at harming Maines' cherished wildlife and will "tweek" the population numbers to look as if there are too many of them so they can trap more. Please do not de-list the Canadian Lynx!

sincerely,

Diane Trifano

(b) (6) P.I.I.

From: McCollough, Mark
To: Margaret Struhsacker
Subject: Re: Stuff
Date: Monday, February 02, 2015 11:42:33 AM

Peggy:

You asked the million-dollar question! As you may know, there are no standard methods for evaluating lynx populations in North America. We are not aware of any states or provinces that estimate lynx populations. Instead, in Canada and Alaska they monitor fur returns, snowshoe hare populations, or perhaps age/sex ratios in the harvested population as indices of lynx trends.

That said, Maine Department of Inland Fisheries and Wildlife recently made an estimate of Maine's lynx population in their Canada (see lynxhttp://www.maine.gov/ifw/wildlife/pdfs/Lynx%20Assessment%202012_1_Final.pdf). They estimate a population of 750 to 1000 adult lynx and explain their methods in Appendix 4 of the assessment. The Service has not officially evaluated or commented on the methods, nor has there been peer review of the methods used.

UMaine graduate student Erin Simons used her lynx habitat model as a basis for estimating lynx population. Her methods were very different and are described in her dissertation. Erin's estimate in 2007 was approximately 236-355 lynx on a 3.56 million acre study area, which comprised about half of the 6.8 million acre lynx critical habitat. Erin is expanding her habitat model to all of northern Maine and perhaps we will have her repeat her population estimate this spring.

In our recent NEPA EA for the lynx trapping ITP, the Service used an estimate of 500 lynx to conservatively evaluate the lethal take of 3 lynx over 15 years. However, we have not done an independent estimate of lynx population in Maine. Nor, to my knowledge, has the Service estimated lynx populations in MN, northern Rockies, or other places where they occur.

Hope this helps. Good talking to you the other day. Mark

On Fri, Jan 30, 2015 at 5:14 PM, Margaret Struhsacker <(b) (6) > wrote:

> Hey,
> I was asked what the latest number on lynx is in Maine? I have been on the phone a bit today!!!
> Peg

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115

Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: Zelenak, Jim
To: McCollough, Mark
Cc: Erin Simons-Legaard
Subject: Re: Looking for hare article
Date: Tuesday, July 14, 2015 9:08:38 AM

I don't have that one, Mark, but would like to. Science Direct wants $36 to download. Recommend calling lead author and asking if she could email a pdf. Let me know if you'd like me to call her.

Anne Allard-Duchêne

Tel.: (b) (6) [redacted]

On Tue, Jul 14, 2015 at 8:52 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Do either of you have a pdf of the ms.:
>
> Allard-Duchene, A., Pothier D, Dupuch A, Fortin D. 2014. Temporal changes in habitat use by snowshoe hares and red squirrels during post-fire and post-logging forest succession. Forest Ecology and Management 313:17-25
>
> Try as I might, I cannot seem to be able to download a pdf through the journal site or the USFWS Literature Search services.
>
> Thanks, Mark
>
> --
> Mark McCollough, Ph.D.
> Endangered Species Specialist
> Maine Field Office
> U. S. Fish and Wildlife Service
> 17 Godfrey Drive, Suite 2
> Orono, ME 04473
> Phone 207 866-3344 x115
> Cell Phone: 207 944-5709
> mark_mccollough@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Nancy Warren
To: Zelenak, Jim
Subject: Re: Wanting to know you are OK
Date: Sunday, September 06, 2015 12:22:03 PM

Hi Jim,
Sorry, I decided to mull this over & then forgot to get back to you with a reply.

As far as experts in boreal forest ecology, I can't think of any other than "the usual suspects" we cited in the LCAS.

For climate change, I might suggest Linda Joyce who is with Rocky Mountain Station in Fort Collins & was a member of the IPCC, or maybe Mike Furniss who I think is still with Pacific Northwest Station on the STREAM Team & has been traveling internationally a lot lately doing workshops on climate change. They both know a lot about climate change, but I'm not sure about the modeling part. They may know some modelers, though. Let me know if you want contact info for either of them.

In mid-October I will be on a road trip to the east coast, probably goofing off somewhere along the Blue Ridge Parkway. So I don't think I could make it to a meeting in Minneapolis. I appreciate you asking, though.

I am actually having a very nice retirement. What I like about the grizzly bear contract is that it's part time, I work on my own schedule, I seldom have to attend any meetings and so far have had no interaction with attorneys! I do sympathize with you; litigation is not very rewarding or much fun. But of course it is quite important. Hang in there. I'll be interested to see how these Lynx decisions play out.

(Maybe while in Minneapolis, you should ask Lori Nordstrom for some career advice. She seems much happier now.)

Take care and let's keep in touch.

Nancy

On Aug 27, 2015, at 7:29 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Thanks Nancy.
>
> Not sure "cleanly written" will sway the judge or compel the plaintiffs, but I appreciate that, especially from someone I consider an excellent science writer (an often thankless job, I think).
>
> I'm swamped trying to meet RSOL and DOJ timeline for responding to the CH lawsuits - 2 briefs and 2 sets of "statements of fact" (Misnomer of the Year candidate if ever there was one....). Some days I think I'm ready (mentally, not financially...) to follow Anne V. right out the door and never look back. Is it that this stuff is just not fun, or do I have an attitude problem?
>
> Sounds like you are keeping busy. That does not sound like "retirement" to me....
>
> On another topic, I am also trying to move forward with a "Species Status Assessment" (SSA - a newish FWS framework) for the lynx DPS, then moving into recovery plan if necessary. Part of that

is lining up an "expert elicitation" workshop in mid-Oct. in Minneapolis, the purpose of which is to pick the experts' brains for knowledge, professional judgement, and opinion on the current and likely future status of lynx in the Lower 48. As well as the usual suspects, I am trying to line up some boreal forest ecology and some climate modeling expertise - of course with an eye toward potential impacts to lynx/hare populations and habitats. Please let me know if any names jump out for you in those arenas, and forward them to me.

Finally, I'd like to have someone there who could get the experts on the same (accurate) sheet of music regarding the differences in the regulatory environment for lynx now versus at the time of listing (how well has the threat for which the DPS was listed been addressed and ameliorated?), to inform the discussion about new or emerging threats, and whether any of those suggest the DPS continues to need the protections of the Act. I've mentioned this to Scott J., but not sure if he will be able to make it and/or agree to present this topic. If not, any chance you'd consider it?

Let me know.

As always, nice to hear from you. Take good care and keep in touch.

Jim

On Wed, Aug 26, 2015 at 4:57 PM, Nancy Warren (b) (6) > wrote:

> Oh good. I just heard from Bob myself this morning and was getting ready to reply to you. Scary and sad.
>
> On another topic, I have been drafting the effects analysis for Lynx for the NCDE grizzly bear amendment DEIS. I was really happy to rediscover that the Federal Register notice you labored over is very clearly written. Thank you for that!
>
> Best wishes,
> Nancy
>
> On Aug 26, 2015, at 7:42 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > FYI - I heard back from Bob.
> >
> > Hope all is also well with you.
> >
> > J
> > ---------- Forwarded message ----------
> > From: **Robert Naney** (b) (6) P.I.I.
> > Date: Tue, Aug 25, 2015 at 3:51 PM
> > Subject: Re: Wanting to know you are OK
> > To: "Zelenak, Jim" <jim_zelenak@fws.gov>
> >
> > thanks for checking jim. so far we have escaped the fires but are heavy in smoke. the real tragedy was the loss of 3 fire fighters on wed. I was in the backcountry doing some bear surveys when the fire broke and came out Friday. my wife did evacuate wed/thurs nights but the fire did nto get closer than about 5 miles. hopjng we

get some north wind and rain soon.

On Tue, Aug 25, 2015 at 12:46 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Hey Bob,
>
> Seems a big chunk over your way is burning up - hope you and yours are safe and out of harms way. Let me know.
>
> Take good care,
>
> Jim
>
> --
> Jim Zelenak, Biologist
> U.S. Fish and Wildlife Service
> Montana Ecological Services Office
> 585 Shepard Way, Suite 1
> Helena, MT 59601
> (406) 449-5225 ext. 220
> jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
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--
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(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From:	Zelenak, Jim
To:	Mark McCollough; Tamara Smith; Bryon Holt; Kurt Broderdorp; Mary Parkin; Heather Bell; Jodi Bush; Seth Willey; Jonathan Cummings
Subject:	Fwd: Canada Lynx Expert Elicitation Workshop
Date:	Friday, September 18, 2015 3:02:05 PM
Attachments:	2015 09 18 LTR Bush_Panelists Re_Lynx SSA Expert Workshop Invite.pdf Attachment 1 - Invitational Traveler Form.pdf Attachment 2 - Hotel Information for Lynx SSA Expert Elicitation Workshop.pdf

---

Jodi and I just sent this to the 10 lynx experts we agreed to on our last call (McKelvey, Harrison, Vashon, Moen, S. Catton, Squires, Kolbe, Ivan, Apps, and Bowman. We have one more slot to fill - a representative for Washington - which Jodi has been working on).

I will be working next on a letter to presenters/other experts that will go out to Jackson, Schwartz, Simons-Legaard, and Hodges (Jodi and I are still discussing Murray).

In addition, we need to reach out to climate modelers. Jodi and I (with Tam's recommendation) have narrowed that group down to Iverson, Lawler, Mote, and Frelich. I will try to reach out to those folks this afternoon, but I may seek some assistance from the Core Team if I cannot reach them today. Jodi also intends to reach out to Robin O'Malley to see if he has other recommendations.

I would have liked to have run the invitation letter by you-all, but we are running out of time and I've been slammed lately with lynx CH lawsuit responses.

I'll be at NCTC next week, but I should have email access there. If any of you need to talk to me, I will also have my cell ((b) (6)), which had pretty spotty (but not zero!) coverage last time I was there.

Hope you all have a great weekend.

---------- Forwarded message ----------
From: **Zelenak, Jim** <jim_zelenak@fws.gov>
Date: Fri, Sep 18, 2015 at 12:45 PM
Subject: Canada Lynx Expert Elicitation Workshop
To:

Hi All:

Please see the attached invitation to participate as lynx expert panelists at the Oct. 13-15 Lynx SSA Expert Elicitation Workshop in Minneapolis, along with the hotel information and invitational traveler form (both also attached).

You are among the group of experts most familiar with the lynx populations in the contiguous U.S. and southern Canada and who we believe can make the greatest contribution to our understanding of the status of, threats to, and future viability of those populations.

Because we needed to keep the panel to a manageable number (10-12) while also getting representation from across the range of the DPS, there are other lynx researchers and experts (your peers) who we were unable to invite to participate as panelists. We hope some of those will nonetheless attend the workshop and present their research results for you on the expert panel to consider.

I hope you are still interested and available to participate as an expert panelist. If you are unable to attend, please let me know at your earliest convenience.

The workshop facilitators and I will be in touch over the coming weeks to provide additional information on the

structured process for the workshop and other details.

Please email or call me if you have any questions, and thanks again for your willingness to participate on this panel.

Cheers!

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
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Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: Bush, Jodi
To: Zelenak, Jim
Subject: Re: Lynx Tribal Question
Date: Friday, September 25, 2015 8:26:44 AM

---

ok

Jodi L. Bush
Field Supervisor
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225, ext.205

On Thu, Sep 24, 2015 at 4:27 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> I should be able to do a call before heading to the airport with Mom. As I said, in last, I could probably do something between 10 and noon Mountain time, maybe a little earlier.
>
> But I will not see email after tomorrow morning, so if this looks to happen, please text date/time and call-in/passcode info to my cell (b) (6)(b) (6)).
>
> Thanks.
>
> On Thu, Sep 24, 2015 at 3:42 PM, Bush, Jodi <jodi_bush@fws.gov> wrote:
>
> > are you available monday? It looks like you are on leave?
> >
> > Jodi L. Bush
> > Field Supervisor
> > Montana Ecological Services Office
> > 585 Shepard Way, Suite 1
> > Helena, MT 59601
> > (406) 449-5225, ext.205
> >
> > On Thu, Sep 24, 2015 at 3:40 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > Hi Ivy,
> > >
> > > Is there any way we can do it Mon. or Tues. next week. I'm at NCTC and need to leave for Dulles right after class tomorrow at lunch so I can exchange work rental for personal rental and get to southeast PA before dark (or too late).
> > >
> > > On Thu, Sep 24, 2015 at 11:56 AM, Ivy Allen <ivy_allen@fws.gov> wrote:
> > >
> > > > Jim, is there a chance you could do the call tomorrow? Everyone could Join.
> > > >
> > > > *Ivy Allen | Tribal Communication Specialist | U.S. Fish and Wildlife Service | Mountain-Prairie Region | 134 Union Blvd., Lakewood, CO 80228 | Ivy_Allen@fws.gov | 303-236-4575*

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, September 15, 2015 2:38 PM
To: Ivy Allen
Cc: Jodi Bush
Subject: Re: Lynx Tribal Question

Thanks Ivy!

That would be great if you could send that email and set up the call based on their responses.

Jim

On Tue, Sep 15, 2015 at 2:10 PM, Ivy Allen <ivy_allen@fws.gov> wrote:

I think I could do that without any problem. Let send them an email and see if they are open to that idea.

Ivy Allen | Tribal Communication Specialist | U.S. Fish and Wildlife Service | Mountain-Prairie Region | 134 Union Blvd., Lakewood, CO 80228 | Ivy_Allen@fws.gov | 303-236-4575

From: Zelenak, Jim [mailto:jim_zelenak@fws.gov]
Sent: Tuesday, September 15, 2015 1:46 PM
To: Ivy Allen
Cc: Jodi Bush
Subject: Lynx Tribal Question

Hi Ivy,

Is there any chance you could line up a conference call soon between me (and maybe my supervisor), you, and your counterparts in regions 5, 3 and 1?

We need to discuss whether we could get one or maybe two tribal representatives to participate as observers at the Lynx SSA Expert Elicitation Workshop we will be holding in Minneapolis Oct. 13-15, and to find out if such representatives might agree to listen and provide information to other tribes in the lynx DPS range (or how we

might best go about asking that).

Give a call if you would like to discuss.

Thanks,

Jim

--
Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

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(406) 449-5225 ext. 220
jim_zelenak@fws.gov

From: McCollough, Mark
To: Erin Simons-Legaard
Cc: Laury Zicari
Subject: Re: lynx meeting changes of plans
Date: Tuesday, October 06, 2015 1:03:23 PM

Erin:

Let's hold off talking for a day. Some in the USFWS want to talk with Dan, offer mea culpa's, etc. with hopes he may change his mind.

If there are changes in plans foryour possible involvement with the Maine presentation, I think you will hear directly from Jim Zelenak in Helena.

Whatever happens, I am here to help you in any way possible. I encourage you to continue to think about a 20 minute presentation concerning the threats that affect lynx and in particular how changes in forest practices, climate, budworm, changing land ownership, development, anthropogenic sources of mortality, and other "threats" will affect lynx into the future. The future will be a big part of our discussion next week and you've done some good thinking and research along those lines.

Thanks for being patient while we work on this.

Mark

On Tue, Oct 6, 2015 at 12:13 PM, Erin Simons-Legaard <erin.simons@maine.edu> wrote:

> Right sorry.
>
> Office is 207.581.2839
> Cell is (b) (6)
>
> If there's time before 1 (i.e. conference call is short) you could call me then.
>
> On Tuesday, October 6, 2015, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Sounds good. I am glad to hear you are still planning to attend.
> >
> > I will know more after our conference call at noon, but this situation has now involved administrators from both regional offices.
> >
> > I do not want to presume anything about your involvement and will try to call you after 4:00.
> >
> > **I need your phone number please!!!!!!!!!!!**
> >
> > **Mark**
> >
> > On Tue, Oct 6, 2015 at 11:40 AM, Erin Simons-Legaard <erin.simons@maine.edu> wrote:
> >
> > > Hi Mark,
> > >
> > > Was just writing you an email in response to your earlier about travel,

which is all set according to Kaimy in Helena.

Yes, I've talked with Dan. He stopped by yesterday to give me the heads up and he's since forwarded me all his emails about the situation. His decision to boycott doesn't change my decision to participate. Our position would assuredly be stronger were he to be there, but c'est la vie.

With regards to the Maine presentation - I'm gonna have to think about that and see what I can dig up from past presentation's from Dan off which to work. The reality is that although I've in a sense lived some of it, aside from the forest change aspect I've spent my time thinking more about lynx future than lynx history in Maine. I don't have Dan's long view perspective on that particular topic.

I will be in lab from 1-4. Do you want to call me @ 4?

Erin

Erin Simons-Legaard
Research Assistant Professor
School of Forest Resources
5755 Nutting Hall
University of Maine
Orono, ME 04469-5755
erin.simons@maine.edu

On Tue, Oct 6, 2015 at 11:21 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Erin:
>
> I don't know if you talked directly to Dan in the last day or two, but much has transpired. The email chain sent by Dan a few minutes ago is probably enough to give you a sense of what is going on.
>
> I have a conference call with Jim Zelenak and the USFWS lynx core team at noon today - our last before the expert workshop next week. I know the Maine situation has already caused quite a stir. I will find out more at noon.
>
> Can I call you this afternoon to discuss?. I have been asked whether you would give the Maine summary presentation, however, I do not want to presume anything nor put you in an equally difficult position. Before any further commitments are made on the Maine presentation I want to talk with you.
>
> I hope you are still planning/feel comfortable attending. Please....
>
> I am on vacation this week in Ottawa at Cathy's mom's. **I don't have your phone**

number here. Can you please email me your phone so I can try to talk with you this afternoon?

Thanks, Mark

--
Mark McCollough, Ph.D.
Endangered Species Specialist
Maine Field Office
U. S. Fish and Wildlife Service
17 Godfrey Drive, Suite 2
Orono, ME 04473
Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

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Phone 207 866-3344 x115
Cell Phone: 207 944-5709
mark_mccollough@fws.gov

From: McCollough, Mark
To: Zelenak, Jim
Cc: Laury Zicari; Mary Parkin; Jodi Bush
Subject: Re: contact info for Erin Simons-Legaard
Date: Wednesday, October 07, 2015 4:24:28 PM

Jim and Jodi:

Thanks for accommodating Erin in the agenda as we discussed this morning. I think this is the best plan, given Dan's decision.

I have not heard from Dan today concerning my request for some data, figures, etc.

I told Marty that Dan may be visiting the RO tomorrow (Thursday) and gave him a contact in Migratory Birds to check with.

I will assume Jim will talk with Erin by the end of today (Wednesday) and I will give Erin a call tomorrow to go over her presentation and provide any help I can. I think she will do well.

Mark

On Wed, Oct 7, 2015 at 3:14 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Thanks Mark.
>
> Jodi and the SSA implementation team are fine with the changes in the agenda you and I discussed, though we have decided not to circulate a revised agenda before the workshop. They also agreed to moving Erin into Dan's vacated slot on the expert panel and making a slot in the "Overview Presentations" part of the agenda for Erin to present her modeling work.
>
> I did not contact Erin this morning and have not done so yet. We wanted to wait to see if Dan would reply to Jodi's voice message from yesterday afternoon and/or discuss the situation with Marty when Dan visited the R5RO today. Jodi has had no reply from him, and based on Marty's last message, Dan seems to not have shown up at the RO today as he was scheduled to do.
>
> Therefore, unless someone suggests otherwise, I will call Erin soon to discuss these changes, and I will later email Jennifer to let he know she will have 20 minutes to provide the status and threats update for the Maine/Northeast lynx population. I don't intend to go into detail with either beyond acknowledging that Dan is unable to participate in the workshop.
>
> Let me know if you have concerns or other thoughts I should consider before contacting Erin and Jennifer.
>
> Thanks.
>
> Jim
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> On Wed, Oct 7, 2015 at 8:21 AM, McCollough, Mark <mark_mccollough@fws.gov> wrote:
>
> > Jim:
> >
> > I appreciate the thought and conversation yesterday on how to resolve concerns in Maine. Please let me know if you talked with Dan and what the outcome may be. I suspect his mind is made up, but I think the overtures we discussed yesterday may salvage relationships, etc.

Thanks for your ideas about identifying Erin as one of the lynx/hare experts and providing an opportunity for her to present Wednesday morning. You will give Erin a call this morning to bring her up to date on these plans and hear her thoughts (and hopefully approval!). Jen would then have the full slot for the Maine presentation.

It will be apparent to all at the workshop that there are differences of opinion concerning the status and future of lynx in Maine. I don't think we can prevent that, nor overlook it. My hope is that these differences can be discussed in a professional manner. Without Dan presenting, the full extent of knowledge on the status of lynx, hares, forestry, and other threats in Maine may not be apparent to all the workshop participants. I trust that we will consider and utilize the full extent of scientific knowledge into our subsequent work. In other words, the workshop is not the final say on the science of understanding lynx, hares, forestry and other threats in the Northeast. I trust that Dan will provide input (perhaps as a peer reviewer) at some point in our process.

Erin's phone numbers:
Office is 207.581.2839
Cell is (b) (6)

I will give Erin a call towards the end of the day and work with her throughout the remainder of the week.

Drop me an email if there is anything significant I need to know from your discussion with Erin or if you want me to call you.

thanks, Mark

,

--
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thanks, Mark

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mark_mccollough@fws.gov

From:	Zelenak, Jim
To:	Mary Parkin; Heather Bell; Jonathan Cummings
Cc:	Jodi Bush; Seth Willey; Kurt Broderdorp; Mark McCollough; Tamara Smith
Subject:	Revised Agenda and participant list, etc.
Date:	Thursday, October 08, 2015 4:30:13 PM
Attachments:	2015 10 08 Revised Lynx SSA Agenda jz_CLEAN.docx 2015 10 08 Lynx SSA Workshop Experts Presenters Observers - revised.docx Cell phone numbers for Lynx SSA Expert Elicitation Workshop.docx

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Revised Agenda - Attached with changes needed to address Maine issues and to reflect the presentation by Simons-Legaard and the remote presentation by Lawler and Wilsey (U Washington Climate modelers). This meant eating into the Day 2 afternoon session a little, so I added time at the end of the day.

Also attached are the revised participant list and team member cell phone numbers

I've also uploaded these to the share drive in the Workshop Materials folder (dated 2015 10 08).

We are putting together participant folders here to give to participants at the start of the workshop. So far, these include:

SSA Fact Sheet
3 Rs
Expert Meetings White Paper

I also intend to put the Ground Rules and participant list/contact info in there.

I'd like Jonathan's, Heather's, and Mary's thoughts on whether we should also put prints of the 4 conceptual models in the folder (they will get folders at 1 PM and we will introduce and project them later in the afternoon) - this way they would have hard copies to take along after the session on Day 1 if they wanted to study them in more detail. Jodi and I have discussed this and think it may be useful to include them.

I'd also like any thoughts from the rest of the group on other materials that would be good to include as hard copies in the participant folders.

Thanks,

Jim

Jim Zelenak, Biologist
U.S. Fish and Wildlife Service
Montana Ecological Services Office
585 Shepard Way, Suite 1
Helena, MT 59601
(406) 449-5225 ext. 220
jim_zelenak@fws.gov

Cell phone numbers for Lynx SSA Expert Elicitation Workshop

Lynx SSA Core Team

Jim Zelenak: (b) (6)
Kurt Broderdorp: (b) (6)
Bryon Holt: (b) (6)
Mark McCollough: 207-944-5709
Tamara Smith: 612-600-1599 (work cell); (b) (6) (personal)

Lynx SSA Implementation Team

Mary Parkin, (b) (6)
Heather Bell, 703-203-1962 (work cell); (b) (6) (personal)
Jonathan Cummings, (b) (6)
Seth Willey, (b) (6)
Justin Shoemaker, (b) (6)

Jodi Bush, (b) (6)

Lynx SSA Expert Elicitation Workshop Teams, Expert Panelists, Presenters and Observers

Lynx SSA Core Team

Jim Zelenak, USFWS - Montana, jim_zelenak@fws.gov, 406-449-5225 ext. 220, (cell: (b) (6))
Kurt Broderdorp, USFWS - Colorado, kurt_broderdorp@fws.gov, 970-628-7186, (cell: (b) (6))
Bryon Holt, USFWS - Idaho, bryon_holt@fws.gov, 509-893-8014, (cell (b) (6))
Mark McCollough, USFWS - Maine, mark_mccollough@fws.gov, 207-866-3344 x115, (cell: (b) (6) P.I.I.)
Tamara Smith, USFWS - Minnesota, tamara_smith@fws.gov, 612-725-3548 ext. 2219, (cell: (b) (6) P.I.I.)

Lynx SSA Implementation Team

Mary Parkin, USFWS - Region 5 (Massachusetts), mary_parkin@fws.gov, (cell: (b) (6))
Heather Bell, USFWS - Headquarters (Washington, D.C.), heather_bell@fws.gov, (cell: 703-203-1962)
Jonathan Cummings, USGS - Patuxent Wildlife Research Center (Maryland), jwcummings@usgs.gov, (cell: (b) (6))
Seth Willey, USFWS - Region 6 (Colorado), Seth_Willey@fws.gov, 303-236-4257
Justin Shoemaker, USFWS - Region 6 (Colorado), justin_shoemaker@fws.gov, 309-757-5800 ext. 214

Lynx Expert	Geographic Area	Affiliation	Contact Information
Kevin McKelvey	DPS-wide (distribution, climate change)	USDA Forest Service - Rocky Mountain Research Station	kmckelvey@fs.fed.us, 406-542-4163
Erin Simons-Legaard	Maine/Northeast	University of Maine	erin.simons@maine.edu, 207-581-2839
Jennifer Vashon	Maine/Northeast	Maine Department of Inland Fisheries and Wildlife	jennifer.vashon@maine.gov, 207-941-4238
Ron Moen	Minnesota/Great Lakes	University of Minnesota and Natural Resources Research Institute	rmoen@d.umn.edu, 218-788-2610
Susan Catton	Minnesota/Great Lakes	USDA Forest Service – Superior National Forest	scatton@fs.fed.us, 218-626-4304
John Squires	Northern and Southern Rocky Mountains (Montana, Wyoming, Colorado)	USDA Forest Service - Rocky Mountain Research Station	jsquires@fs.fed.us, 406-542-4164
Jay Kolbe	Northern Rocky Mountains	Montana Fish Wildlife and Parks	(b) (6) P.I.I. , 406-499-2356
Ben Maletzke	Washington	Washington Department of Fish and Wildlife	Benjamin.Maletzke@dfw.wa.gov, 509-592-7324
Jake Ivan	Colorado/Southern Rocky Mountains	Colorado Parks and Wildlife	jake.ivan@state.co.us, 970-472-4310 cell: (b) (6)
Jeff Bowman	Southern Canada/Ontario	Ontario Ministry of Natural Resources and Forestry, University of Trent, Ontario	jeff.bowman@ontario.ca, 705-755-1555

Presenters/ Other Experts	Geographic Area	Affiliation	Contact Information
Scott Jackson	DPS-wide (Federal regulatory environment)	USDA Forest Service- Northern Regional Office	sjackson03@fs.fed.us, 406-329-3664
Michael Schwartz	DPS-wide (genetics)	USDA Forest Service - National Genomics Center for Wildlife and Fish Conservation	michaelkschwartz@fs.fed.us, 406-542-4161
Karen Hodges	Southern Canada/DPS-wide (hares, range periphery considerations)	University of British Columbia–Okanagan	karen.hodges@ubc.ca, 250-807-8763
Josh Lawler[1]	Northwest (climate forecasting/species response)	University of Washington	jlawler@u.washington.edu, 206-685-4367
Chad Wilsey[1]	Northwest (climate forecasting/lynx response)	California Audubon	cwilsey@audubon.org, 415-644-4615
Lee Frelich	Lake States (climate modeling/boreal forest response)	University of Minnesota	freli001@umn.edu, 612-624-3671
Alexej Siren	Northeast (climate modeling/snow/lynx response)	University of Massachusetts, DOI NE Climate Science Center	asiren@umass.edu, cell (b) (6)

[1] Presenting remotely.

Observers	Geographic Area	Affiliation	Contact Information
Richard J. Baker	Minnesota	Minnesota Department of Natural Resources	richard.baker@state.mn.us, 651-259-5073
Nichole (Cudworth) Bjornlie	Wyoming	Wyoming Game and Fish Department	nichole.cudworth@wyo.gov, 307-332-7723 ext. 230
Nathan Roberts	Wisconsin	Wisconsin Department of Natural Resources	NathanM.Roberts@wisconsin.gov, 715-490-9345
Bill Rowdy		National Park Service	
Jodi Bush	Montana	USFWS - Montana Ecological Services Field Office	jodi_bush@fws.gov, 406-449-5225, ext.205

LYNX SSA EXPERT ELICITATION WORKSHOP
BLOOMINGTON, MINNESOTA
OCTOBER 13-15, 2015

DAY ONE (Tuesday, October 13)

1:00 Welcome (Bush)
Introductions (All)
Goals/Background (Willey/Zelenak)
Review Agenda (Bell/Parkin)
1:45 SSA Framework/FACA/APA (Bell)
2:15 Expert Elicitation Process (Parkin/Cummings)

Overview Presentations:

2:30 Historic and Current Distribution of Lynx in the Contiguous U.S. (McKelvey)
3:00 Lynx Regulatory Environment 2000-2015 (Jackson)
3:30 Break (15 minutes)
3:45 Lynx Genetics Considerations (Schwartz)
4:15 Lynx Distribution, Status and Management in Southern Canada (Bowman)

4:45 Introduction and Discussion of Lynx Conceptual Models
5:45 Adjourn

DAY TWO (Wednesday, October 14)

PART 1: Overview Presentations (continued):

8:00 Climate Change and Lynx (Frelich, Siren, [Lawler and Wilsey via WebEx])
9:00 Forest Management and Lynx Habitat Trends (Simons-Legaard)
9:30 Snowshoe Hare Distribution & Status in the U.S. and Southern Canada (Hodges)
10:00 Break (15 minutes)

PART 2: Lynx Population Status and Threats Updates:

10:15 Maine/Northeast (Vashon)
10:45 Minnesota/Upper Midwest (Moen)
11:15 Montana and Greater Yellowstone (Squires)
11:45 Northern Washington (Maletzke)
12:15 Colorado/Southern Rockies (Ivan)
12:45 Lunch (1 hour)

PART 3: Expert Elicitation on Aspects of Lynx Analytics

1:45 Review of Lynx Conceptual Models:
Population-level relationships
Species-level relationships (3 Rs: Resiliency, Redundancy, and Representation)
Stressors that affect population and species viability, with a particular focus on climate change

3:30 Rapid Prototyping:
Explore current conditions for the lynx using the conceptual model and, as needed, population models (positive and negative effects on species viability), including regional differences

5:30 Adjourn

DAY THREE (Thursday, October 15)

8:00 Recap and Discussion of Day 2 Results

9:00 Future Scenarios:
Climate change
Other threats
Conservation interventions

10:15 Break (15 minutes)

10:30 Rapid Prototyping:
Begin to project future species conditions based on projected responses to alternative future scenarios

12:00 Lunch

1:00 Rapid Prototyping:
Continue to project future species conditions based on projected responses to alternative future scenarios

3:00 Discussion of results and additional assessment needs

4:00 Wrap-up and next steps

5:00 Adjourn

From: Alexej Siren
To: "McCollough, Mark"
Subject: RE: additional question or two about climate change citations
Date: Friday, April 08, 2016 3:32:46 PM

Hello Mark,

I just tried calling your cell phone because your office line isn't working. My number is: (b) (6) (b) (6)

Thanks,

Alexej

From: McCollough, Mark [mailto:mark_mccollough@fws.gov]
Sent: March 31, 2016 8:06 AM
To: Alexej Siren <asiren@umass.edu>
Subject: Re: additional question or two about climate change citations

The Number 9 wind project is proposed for townships surrounding Number 9 pond in Aroostook County.

I will be out of the office most of next week. I will be in on Friday, April 8. You are welcome to call then.

Look forward to our discussion. Mark

On Wed, Mar 30, 2016 at 5:12 PM, Alexej Siren <asiren@umass.edu> wrote:

> Very interesting. Is the proposed wind project in northern Maine? I look forward to hearing more about this project. Are you available for a phone conversation later next week?
>
> Alexej
>
> **From:** McCollough, Mark [mailto:mark_mccollough@fws.gov]
> **Sent:** March 30, 2016 4:57 PM
> **To:** Alexej Siren <asiren@umass.edu>
> **Subject:** Re: additional question or two about climate change citations
>
> Thanks so much. I will be reading these tomorrow!
>
> Yes, we should talk about intensive collection of genetic samples in a defined area as a way to estimate lynx population (at least for that area). I believe the contractor is going to use some type of mark-recapture estimate of lynx identified to individual to estimate the population that may be affected by the construction and operation of the wind project. We have strongly recommended they do telemetry study to evaluate effects, but they refuse (thus far)....

Mark

On Wed, Mar 30, 2016 at 4:50 PM, Alexej Siren <asiren@umass.edu> wrote:

> Mark,
>
> Attached are the two references that you requested. The Bryan et al. (2015) is a chapter (chapter 1) within the Staudinger et al. (2015) report. Below are the references.
>
> Staudinger, M. D., T. L. Morelli, and A. M. Bryan. 2015. Integrating Climate Change into Northeast and Midwest State Wildlife Action Plans. DOI Northeast Climate Science Center
>
> Rawlins, M.A., Bradley, R.S. and Diaz, H.F., 2012. Assessment of regional climate model simulation estimates over the northeast United States.Journal of Geophysical Research: Atmospheres, 117(D23).
>
> Regarding lynx… we are continuing to get pictures and tracks throughout the winter in northern Pittsburg which makes me lean towards resident individuals. Recently we detected a lynx where I did my marten research which was pretty neat because it's further to the south and I never detected lynx during 2.5 years of year round fieldwork. Lynx tracks were detected in the same location earlier in the winter and after backtracking it to obtain genetic samples I had the feeling it was a resident. It seemed to know the area very well and was scent marking the entire time I backtracked it. Interestingly, a bobcat was either following it or being followed by the lynx because their tracks overlapped and looked to be similar in age. By my assessment, the bobcat looked to be a large tom. I obtained a scat and a large hair sample from the bed.
>
> At some point I'd like to chat with you more about collecting genetic data. I have always thought that your idea of doing intensive snow track surveys to collect genetic data made sense and I have been exploring ideas of collecting both lynx and bobcat samples. If I could help you out at all with collecting data that would be great.
>
> Let me know if you need any more information!
>
> Alexej
>
> **From:** McCollough, Mark [mailto:mark_mccollough@fws.gov]
> **Sent:** March 30, 2016 4:15 PM
> **To:** Alexej Siren <alexejpksiren@gmail.com>
> **Cc:** Jim Zelenak <jim_zelenak@fws.gov>
> **Subject:** additional question or two about climate change citations
>
> Alexej:
>
> I am back to writing the climate change section of the lynx SSA (or at least focusing on the Northeast part of that section).

I've carefully reviewed your previous emails. Thanks so much for providing additional citations and sources of information on snow, particularly in the West. I've forwarded to our biologists writing those sections.

I am still trying to track down two citations on the Northeast slide in your power point:

Rawlings et al. 2012

Bryan (or Brian) et al. 2015

could you please provide a full citation (or better yet pdfs if you have them)?

Glad to hear you are picking up more lynx in NH. Do you think they are resident (i.e. breeding) or dispersers? Are you picking them up consistently in these areas on your cameras? Are you going to keep your cameras operating after winter?

We have a consultation doing camera studies this winter for a proposed, large (6 township, 125 turbine) wind project in lynx critical habitat. They are getting a large number of photos and genetic samples to determine the distribution of lynx in the area and hopefully a population estimate.

Thanks again for your help.

Mark

--
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From: Smith, Tamara
To: Ragan, Laura
Subject: Re: Canada lynx SSA draft report review
Date: Tuesday, October 25, 2016 4:42:43 PM

---

okay yes - Give me a call when you can. I'll be working from home (b) (6) .

On Tue, Oct 25, 2016 at 4:36 PM, Ragan, Laura <laura_ragan@fws.gov> wrote:

> Tam -
>
> Yes, lets talk tomorrow if we can. I don;t think anyone here will be able to meet the requested deadline from R6. Alisa, Tom and I were on the briefing call last week.
>
> -Laura
>
> On Tue, Oct 25, 2016 at 3:52 PM, Smith, Tamara <tamara_smith@fws.gov> wrote:
>
> > Hi Laura - As you are aware, the lynx SSA draft report was sent out to for regional internal review. Were you (or anyone else at the RO) planning on reviewing the document? You can give me a call sometime to discuss if you like.
> >
> > Thanks!
> > -Tam
> >
> > --
> > Tamara Smith
> > U.S. Fish and Wildlife Service
> > Twin Cities Field Office
> > 4101 American Boulevard East
> > Bloomington, MN 55425
> > 952-252-0092, Ext. 219 (new number)
> > 952-646-2873 (new fax number)
> >
> > 612-600-1599 Cell
>
> --
> Laura Ragan
> U.S. Fish and Wildlife Service
> Division of Endangered Species
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> Bloomington, MN 55437
> Tel: 612-713-5157
> Laura_Ragan@fws.gov

--
Tamara Smith
U.S. Fish and Wildlife Service
Twin Cities Field Office

4101 American Boulevard East
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952-646-2873 (new fax number)

612-600-1599 Cell

From:	Jodi Bush
To:	barbara_chavez@fws.gov; Kaimy Marks
Subject:	Fwd: lynx
Date:	Tuesday, December 27, 2016 3:55:34 PM
Attachments:	Untitled attachment 17785.htm 2016 12 27 DRAFT Lynx SSA Report CLEAN.docx

---

Okay. It's time. I need Carrie to get the Table of contents right with links. Barb can provide pointers if Carrie needs it but Barb needs to work on downloading lit cited as pdfs to burn on dvds. See message below. This is a priority! Thanks. And note that Carrie is NOT on this email (I don't have her email address). Thanks. JB

Sent from my iPhone

Begin forwarded message:

From: "Zelenak, Jim" <jim_zelenak@fws.gov>
To: Jodi Bush <jodi_bush@fws.gov>
Subject: Re: lynx

Attached.

If Barb and Carrie can get the TOC to work, that would be great - I haven't tried messing with it.

Then they will save it as a PDF that we will send to peer review contractor, correct.

We had talked about including a note to contractor and peer reviewers that Lit Cited is Draft/incomplete, but if they need copies of particular docs to contact me.

We were also going to have Barb try to burn the Lit cited PDFs from the google drive and save them to disc or thumb drive for the contractor and each peer reviewer, yes?

I'll keep checking email a couple times per day to see if anything requires my attention. Call if something is needed quickly.

On Tue, Dec 27, 2016 at 8:40 AM, Jodi Bush <jodi_bush@fws.gov> wrote:

> I haven't looked at version you sent Friday. So send me update. It's going to Barb and Carrie today. JB
>
> Sent from my iPhone
>
> On Dec 27, 2016, at 7:51 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
>
> > I've continued with some work - page numbers "DRAFT" watermark.
> >
> > Let me know if you want this (with these changes) now/soon or if Barb is working on this stuff along with Table of Contents.
> >
> > I will email State and internal partners today to cancel tomorrow's scheduled State coordination call, and also to push back the internal coordination call scheduled for Tues. Jan. 3.

Let me know if the draft I sent last Friday has gone to peer review contractor or if it still needs work next few days before being sent.

Thanks.

On Fri, Dec 23, 2016 at 10:15 AM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:

> Clean draft attached, with revised Exec. Summ. and draft (incomplete) Lit Cited.
>
> I have some running around to do but will check back in this afternoon to see if anything else is needed.
>
> My cell is (b) (6) in case we need to talk before then.
>
> On Thu, Dec 22, 2016 at 4:18 PM, Jodi Bush <jodi_bush@fws.gov> wrote:
>
> > Ok
> >
> > Sent from my iPhone
> >
> > On Dec 22, 2016, at 3:44 PM, Zelenak, Jim <jim_zelenak@fws.gov> wrote:
> >
> > > I've got two more paragraphs to review/edit to finalize the Exec. Summ., and I need to pull the lit cited list off the drive and mess with it a little.
> > >
> > > Right now I have to get Abby from school and to ballet practice.
> > >
> > > I will work on these from home tomorrow morning and get you the full doc by lunch time, hopefully before then.
> > >
> > > --
> > > Jim Zelenak, Biologist
> > > U.S. Fish and Wildlife Service
> > > Montana Ecological Services Office
> > > 585 Shepard Way, Suite 1
> > > Helena, MT 59601
> > > (406) 449-5225 ext. 220
> > > jim_zelenak@fws.gov
>
> --
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Species Status Assessment

for the

CANADA LYNX *(Lynx canadensis)*

Contiguous United States Distinct Population Segment



Photo by Keith Williams

Version 1.0 - Draft
December 2016

U.S. Fish and Wildlife Service
Regions 1, 3, 5 and 6*

* This SSA report was written by the Canada Lynx Species Status Assessment Team (Lynx SSA Team), which consists of a Core Team of Service biologists who work on lynx issues across the DPS range and an SSA Framework Implementation Team of Service and U.S. Geological Survey staff who have developed and advanced the SSA framework. Core Team members also participate on the Interagency Lynx Biology Team (ILBT) and contributed to the recently-revised Lynx Conservation Assessment and Strategy (LCAS; ILBT 2013, entire).

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5.2.1 Results of Expert Elicitation (workshop report, Summary table of probabilities of persistence)
Chapter 6: Synthesis

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Executive Summary

Background

This report presents the results of a species status assessment (SSA) conducted for the contiguous United States (U.S.) distinct population segment (DPS) of Canada lynx (*Lynx canadensis*). The DPS was listed in 2000 as threatened under the Endangered Species Act (ESA) because of the inadequacy, at that time, of existing regulatory mechanisms on Federal lands. The SSA will provide the scientific basis for the statutorily required 5-year status review for this listed species and other decisions the U.S. Fish and Wildlife Service (Service) is required to make in accordance with the ESA. The SSA provides an evaluation of the current and possible future conditions for lynx in the six geographic units within the DPS that currently support or recently supported resident lynx populations. The units are distributed across the northern contiguous U.S. from Maine to Washington and south along the Rocky Mountains to western Colorado (Figure 1).

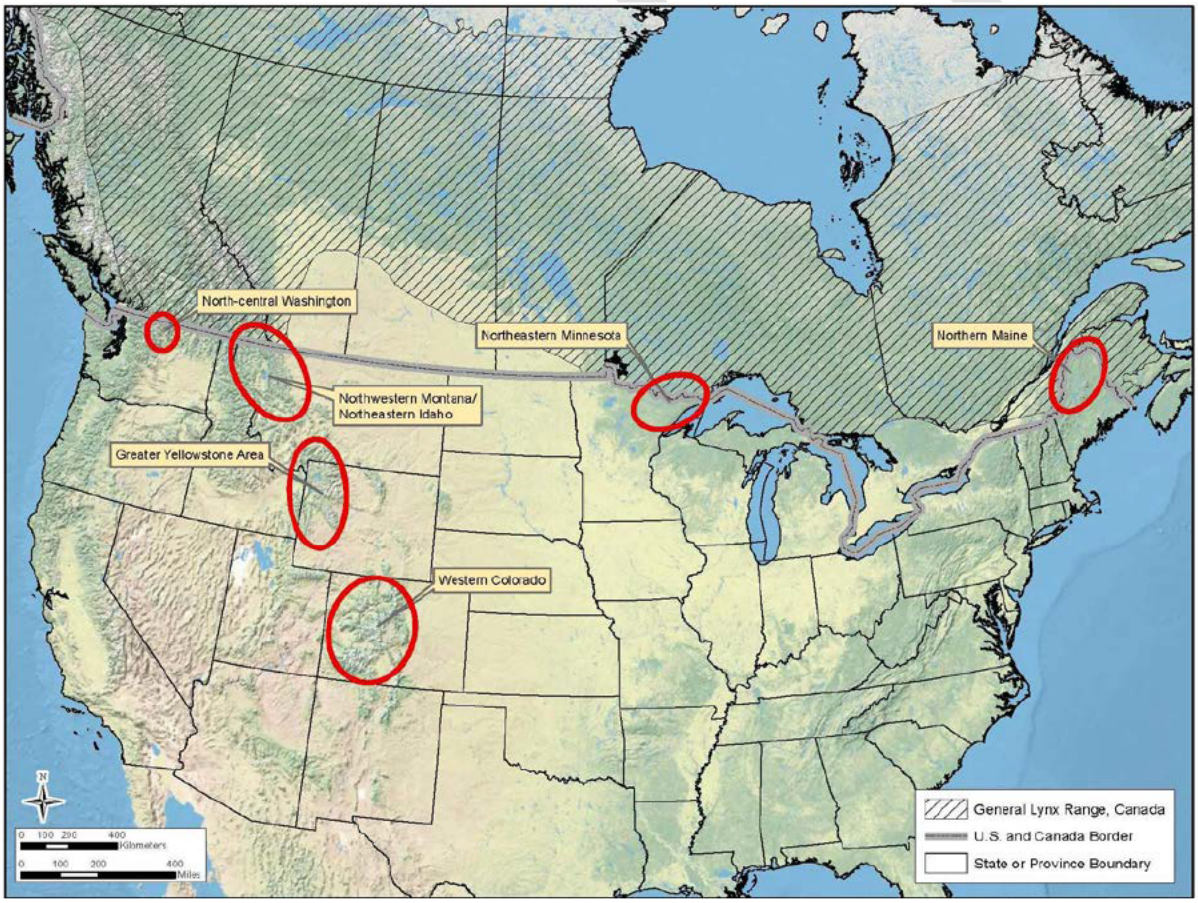


Figure 1. Six geographic units within the range of the contiguous U.S. distinct population segment of Canada lynx (*Lynx canadensis*).

These units encompass the geographic areas in the contiguous U.S. with the strongest historical and/or recent evidence of an ability to support persistent resident lynx populations

and, combined, they represent approximately the southern two percent of the species' entire breeding range (98 percent occurs in Canada and Alaska). The units are relatively isolated from each other, but four of the six units are directly adjacent to lynx populations and habitats in Canada. Although lynx are regularly or occasionally documented in other parts of the northern contiguous U.S., usually peripheral to the SSA geographic units, the ability of these peripheral areas to support persistent resident lynx populations remains questionable. Lynx may occur in such areas as small and ephemeral breeding populations or as occasional dispersing or transient individuals. The locations and sizes of the SSA geographic units are summarized in Table 1.

Table 1. Canada Lynx SSA Geographic Units.

Unit No.	Unit Name and Location	Unit Size (km^2)
Unit 1	Northern Maine	28,909
Unit 2	Northeastern Minnesota	21,101
Unit 3	Northwestern Montana/Northeastern Idaho	26,997
Unit 4	North-central Washington	5,176
Unit 5	Greater Yellowstone Area	23,687
Unit 6	Western Colorado	25,294

This report represents the Service's evaluation of the best available scientific information, including the formally-elicited professional judgments and opinions of recognized lynx experts. Based on this information, we: (1) describe the ecological requirements and population dynamics of the species; (2) evaluate the historical and current condition of lynx populations in the DPS, including the six geographic units, and the factors that appear to have influenced them; and (3) assess the future viability of the DPS in the near term (through the year 2025), mid-term (through 2050), and through the end of this century in terms of the conservation biology principles of resiliency, redundancy, and representation (the "3 Rs").

The lynx is a habitat and prey specialist that requires dense boreal and subalpine forests having long winters with deep, fluffy snow and abundant snowshoe hares, which typically comprise >90 percent of the lynx's year-round diet. The lynx has evolved morphological adaptions (long legs and large paws) that allow it to efficiently travel and capture hares in snow conditions that are difficult for most other terrestrial hare predators (e.g., bobcats, coyotes). These characteristics provide lynx with a seasonal (4-5 months in most of the DPS) competitive advantage over other hare predators and allow them to occupy habitats that are unavailable to some of their competitors.

The DPS occurs at the southernmost margin of the species' range and of the environmental thresholds of snow quality, depth, and persistence; hare density; and boreal forest conditions

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that lynx require. Because of this, lynx habitats and, thus, lynx are naturally less abundant and more patchily distributed in the DPS than in the core of the species' range in Canada and Alaska. Maintaining connectivity between the DPS and lynx populations in Canada is thought to be important, but whether the demographic and/or genetic health of DPS populations depends on intermittent immigration of lynx from Canada and, if so, to what extent remain uncertain.

Research and surveys undertaken since the DPS was proposed for listing in 1998 have significantly improved our knowledge of the distribution, habitats, and population dynamics of lynx in the contiguous U.S. For example, analysis of historical records in the U.S. and Canada indicated that many lynx records in the contiguous U.S. coincided with intermittent "irruptions" (mass dispersal events) of lynx from Canada into the northern U.S. when hare populations in Canada underwent cyclic declines (every 8-11 years). During these irruptions, large numbers of lynx occurred temporarily in (and disappeared quickly from) areas that we now believe are naturally incapable of supporting resident populations.

Additionally, although we knew resident lynx occurred in Maine, we lacked information on the historical and recent distribution and quality of lynx habitat. We now know that forest regeneration after large-scale clear-cutting in the 1970s and 1980s has contributed substantially to the current broad distribution of high-quality habitat in northern Maine, which currently supports the largest resident lynx population in the DPS. Similarly, we were uncertain if Minnesota supported a resident breeding population, but we now know that a persistent population occupies the northeastern corner of the state. Research and monitoring also suggest that lynx and habitats in the western U.S. are naturally less abundant and more patchily distributed than was thought at the time of listing, and lynx may have been extirpated recently from several areas thought to have previously supported small resident populations (e.g., the Kettle Mountains in northeastern Washington, the Garnet Mountains in western Montana, and the Greater Yellowstone Area of southwestern Montana and northwestern Wyoming). We also know that recent extensive wildfires in north-central Washington have temporarily reduced the amount of high-quality lynx habitat and have probably caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999 to 2006 and the subsequent survival and reproduction of some of these lynx and their offspring, resident lynx currently occupy parts of western Colorado.

SSA Framework

The framework for conducting an SSA takes into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time. Therefore, we evaluated the ecological requirements of individual lynx and populations and the current and possible future conditions for resident lynx populations in each geographical unit to assess the viability of the DPS. The SSA uses the conservation biology principles of resiliency, redundancy, and representation as the framework for assessing current and future conditions. Resiliency describes the ability of the species to withstand stochasticity, redundancy describes the ability of the species to withstand catastrophic events, and representation describes the ability of the species to adapt over time to long-term changes in the environment. The 3 Rs can

be influenced by any number of factors. For lynx, the factors evaluated in this SSA include: (1) the original factor for which the DPS was listed as threatened (the inadequacy of existing Federal regulatory mechanisms at the time of listing); (2) the factors considered by the Interagency Lynx Biology Team (ILBT) to have the potential to exert population-level effects on the DPS (climate change, vegetation management, wildland fire management, and habitat loss and fragmentation); and (3) other factors that could influence the continued ability of particular geographic units to support resident lynx.

Uncertainties and Assumptions

Several primary sources of uncertainty had to be accounted for in our analysis, including the dearth of empirical data on lynx population sizes, trends, and other important demographic parameters in the DPS; the influence of immigration of lynx from Canada on the persistence of DPS populations; the effectiveness of habitat management efforts; and the effects of competition on lynx populations. We lack similar demographic information for snowshoe hares throughout much of the DPS. Additionally, consistent methods to monitor hare and lynx habitats have not been implemented throughout most of the DPS. And importantly, given the emerging role of climate change as a stressor, uncertainties about the rate and extent of projected future declines in snow quality, depth, and persistence, and in the northward and upslope retraction of boreal, subalpine, and montane forests constrain our ability to precisely predict effects on lynx and snowshoe hare populations and habitats, including to what degree these changes may affect interactions between lynx and their competitors.

To account for these uncertainties in our analysis, we identified a number of critical assumptions based on the literature and input provided by the lynx experts we consulted. We treated the following assumptions as constants in the analysis.

- We assume that, in general, habitat quality, hare densities, and lynx numbers are naturally lower and hares noncyclic or weakly cyclic at the southern margin of the lynx's range, including the DPS, than in the core of the species' range in Canada and Alaska.

- We assume that as a consequence of generally lower habitat quality and hare densities, only some places within the DPS range are capable of supporting persistent resident lynx populations, while others may naturally support resident lynx only ephemerally, and yet other areas are naturally incapable of supporting resident lynx despite boreal-forest-like vegetation and the presence of some hares.

- We assume that lynx populations in the DPS occur as the southern extensions of larger, cross-border populations or as relatively isolated subpopulations of the larger Canadian populations.

- We assume that lynx exhibit a "mainland-island" metapopulation structure in which DPS populations function as "islands" that receive periodic input from "mainland" Canada populations.

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- We assume that connectivity with larger lynx populations in Canada is important, and that periodic immigration of lynx into the DPS from Canada contributes to the persistence of DPS populations, although the extent to which the demographic and genetic health of DPS populations depends on immigration remains uncertain.

- We assume that lynx in the DPS require specific snow conditions (deep, "fluffy," and persistent) to express a competitive advantage over bobcats and other terrestrial hare predators, and that in the absence or loss of these conditions, lynx will be displaced by other hare predators.

- We assume that the lynx, as a boreal forest- and snow-reliant predator that relies heavily on a single, similarly-specialized prey species, and whose habitats are influenced by climate-mediated disturbance factors (e.g., wildfire, forest insects, wind/ice storms, etc.), is highly sensitive and broadly exposed to the impacts of climate change and has limited adaptive capacity to respond to it. Therefore, we assume lynx populations in the DPS are vulnerable to the projected impacts of continued climate warming.

- We assume that lynx conservation measures and habitat management guidance adopted by the U.S. Forest Service (USFS) and the Bureau of Land Management (BLM) via formally amended or revised management plans have had a positive influence on DPS lynx populations that occur on Federal lands and will continue to do so as long as those measures and guidance are implemented.

- We assume that the DPS could be delisted in the future and that some of the current protections afforded by the ESA could be lost and/or relaxed. However, we assume conditions for delisting would include requirements and incentives to continue to conserve lynx and its habitats and to try to assure persistence of resident lynx populations in those places that can support them in the DPS range.

For purposes of the SSA, we forecast potential future conditions for lynx in the DPS through year 2100. Beyond that timeframe, uncertainty regarding the potential impacts of climate change and other potential stressors to lynx populations in the DPS becomes so great as to preclude meaningful analysis or projections of viability.

Current Conditions

The current distribution of resident lynx in the contiguous U.S. is likely somewhat smaller than the historical distribution because of the potential loss of small populations in several places (e.g., northern New Hampshire, perhaps the Adirondack Mountains of northern New York, Isle Royale in Lake Superior, the Kettle Mountains of northeastern Washington, and, more recently, the Greater Yellowstone Area of Southwestern Montana and northwestern Wyoming, and perhaps the Garnet Mountains in western Montana). However, based on verified historical records, we lack compelling evidence that the current distribution and relative abundance of

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resident lynx in the DPS range are substantially diminished from historical conditions, and resident populations continue to persist in the geographic areas with the strongest historical evidence of an ability to support them. Nonetheless, in many parts of the DPS range habitat features (forest distribution and structure, hare densities, and snow conditions) appear to exist at or just above thresholds thought necessary to support persistent lynx populations.

Resiliency – The apparent long-term (historical and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historical conditions suggest adequate historical and recent levels of resiliency among lynx populations in the DPS. Among these units, lynx in Maine appear to have recently demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the current absence of resident lynx in the Garnet Mountains of Unit 3 (a small and somewhat isolated mountain range at the southern periphery of Unit 3) may suggest a recent decline in resiliency in this part of the unit. The persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population. However, the post-fire increase in home range size and likely decrease in lynx numbers may indicate the population in Unit 4 is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Among the other two geographic units, the current absence of resident lynx in the GYA (Unit 5) despite the large proportion of lands in conservation status (e.g., national parks and designated wilderness areas) may indicate the naturally lower level of resiliency expected among small and relatively more isolated populations. In western Colorado (Unit 6), the absence of resident lynx for much of the past century may indicate historically inadequate resiliency in this unit. However, the recent persistence of resident lynx in this unit following the 1999-2006 introduction of 218 Canadian and Alaskan lynx suggests recent resiliency thus far. We conclude that the DPS as a whole currently demonstrates adequate resiliency despite the possibility that resiliency may have declined recently in several geographic units.

Redundancy – The current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a single catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southwestern Colorado. Resident breeding lynx populations currently occupy five of the six geographic units (all but the GYA; Figure 1). Of the five occupied units, four are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2) (Table 1). We find that no single catastrophic event could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS or of any of the individual geographic units that currently support resident populations. Because we lack evidence that persistent lynx populations have been lost from any other large geographic areas in the contiguous U.S., it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. We conclude that the DPS currently demonstrates adequate redundancy to preclude the possibility of extirpation via catastrophic event.

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Representation – The high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the lynx's range, including the DPS, suggest the absences of current threats to the genetic health of lynx populations in the DPS. Although hybridization with bobcats has been documented in Maine and Minnesota, it is not considered a substantial current threat to the DPS. Similarly, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S., suggesting relative maintenance of the breadth of diversity of ecological settings occupied within the DPS range. Because there are no indications of significant loss of or current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to indicate a decrease from historical conditions, we find that the DPS currently displays an adequate level of representation.

Future Conditions

We and the lynx experts we consulted expect that the number of resident lynx and the distributions of resident populations in the DPS range will decline through the end of the century largely as a result of projected continued climate warming and associated impacts, which are likely to exacerbate the potential adverse effects of other factors (e.g., forest management, competition from other hare predators). Continued warming is expected to cause a northward and upslope retraction of the boreal forest and snow conditions that lynx need, resulting in smaller, more fragmented, and increasingly isolated patches of habitat and a reduced probability of persistence for all resident populations in the DPS range. We expect that resident populations will persist through mid-century in all five of the geographic units that currently support them (albeit in reduced numbers and distributions), but that lynx may be functionally extirpated (loss of the ability to support persistent resident populations) from two or three of the units by the end of the century.

The western geographic units (units 3 through 6) may be more likely to support resident lynx longer than units 1 and 2 under projected climate change scenarios given the higher percentage of land managed specifically for lynx conservation and their greater topographic potential to facilitate the upward elevational shift in in lynx habitats projected by climate models. Nonetheless, we are unaware of any management actions that can be expected to abate the projected long-term retreat of boreal forests and diminished snow conditions expected under continued climate warming. Further, climate-induced frequency and intensity of wildfires and forest insect outbreaks are expected to increase, particularly in the western portion of the DPS, although we do not anticipate such events alone to cause the permanent loss of breeding lynx populations in any geographic unit. In Minnesota and Maine (units 1 and 2), suitable boreal forest and snow conditions are projected to decline more severely than in the western units, and in some climate modeling scenarios they could disappear completely from these units by the end of the century. Over the next 15-20 years, lynx habitat conditions in Maine are also likely to decline significantly from current historically high and anthropogenically influenced levels as

private forest management practices, particularly a shift away from landscape-level clearcutting, result in forest succession detrimental to snowshoe hare and lynx needs.

Resiliency – We expect resident lynx populations in all geographic units that currently support them to be smaller and more fragmented and isolated in the future, and each geographic unit and the DPS as a whole will, therefore be less resilient in the future. We anticipate that resiliency will likely be adequate to foster persistence of resident lynx in most units through mid-century but that it will be substantially diminished after that time, with resulting extirpation of resident populations from two to three (of five) units by the end of the century. Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit, although uncertainty remains regarding the timing, extent, and biological consequences of such impacts. As vegetation and snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

Redundancy – Although redundancy in the DPS will decline with the projected loss of populations from two or three geographic units by the end of the century, our evaluation suggests that none of individual geographic units that currently support resident lynx are vulnerable to extirpation from a single catastrophic event. Given that, we conclude that the DPS as a whole is not vulnerable to extirpation from a catastrophic event. We recognize that a sequence of discrete but spatially-clustered catastrophic events in lynx habitats over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (especially the possibility of additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS (and we expect populations to persist in two or three of five units by the end of the century), extirpation of the DPS from a single catastrophic event is very unlikely.

Representation – Although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently observed and expected future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, and the current and likely future connectivity and absence of significant barriers to dispersal between Canada and most DPS geographic units. Based on these factors and expert input, we find that is there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future and no indication that future gene flow is likely to be substantially reduced. This information suggests the current and likely future relative genetic health of the DPS. How the potential loss of resident lynx from one or more geographic units may affect representation within the DPS in terms of ecological diversity is uncertain. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow

conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

DPS-wide Synthesis

We and the lynx experts we consulted expect that resident lynx populations are likely to continue to persist, albeit in reduced numbers and distributions, in all five geographic units that currently support them through mid-century, but that functional extirpation is likely in two to three of those units by the end of the century, driven largely by projected continued climate warming. Because resident lynx in many parts of the DPS persist in areas that appear naturally to barely meet thresholds for hare densities and habitat quality and distribution, relatively small declines in these features could result in loss of the ability to support resident populations over large areas. Because of this, we believe that future lynx habitats and resident populations throughout the DPS range are likely to be smaller and more fragmented, and geographic units that are already relatively isolated from other lynx populations are likely to become even more isolated in the future. Uncertainty increases at mid- to late-century regarding the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in concert with input from lynx experts suggests that the probability of the persistence of resident breeding populations will decline in all geographic units, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

Because resident lynx populations in all geographic units that currently support them are expected to be smaller and more fragmented and isolated in the future, each geographic unit and the DPS as a whole will be less resilient in the future. Our analyses and expert input suggest that resiliency will likely be adequate to foster persistence of resident lynx through mid-century in most of the five geographic units that currently support them. However, we believe it is very unlikely that resident lynx populations will persist through the end of this century in all of the geographic units that currently support them. That is, we believe that resiliency will be substantially diminished because of reduced population sizes and distributions throughout the DPS, with resulting extirpation of resident populations from two to three (of five) units more likely than not by the end of the century.

We conclude that the functional extirpation of resident lynx populations from one or more geographic unit would demonstrate a loss of resiliency, reduced redundancy, and, possibly, reduced representation within the DPS. The probability of losses in resiliency, redundancy, and representation puts the Canada lynx DPS at increasing risk of extirpation through the end of this century.

Chapter 1: Introduction

The U.S. Fish and Wildlife Service (Service) designated lynx in the contiguous U.S. as a distinct population segment (DPS) and listed it as threatened under the Endangered Species Act of 1973, as amended (ESA) in 2000 (65 FR 16052-16086). On May 8, 2014, the United States

District Court for the District of Montana ordered the Service to complete recovery planning for the lynx DPS (U.S. District Court MT 2014a, p. 8). On June 25, 2014, the same court ordered the Service to complete a recovery plan by January 15, 2018 "…unless the Service finds that such a plan will not promote the conservation of the [lynx]" (U.S. District Court MT 2014b, p. 2). Thus, we conducted this SSA (version 1.0) to summarize the best available information on the current status and likely future viability of the DPS. This SSA will inform a determination by Service decision makers of whether (1) the DPS continues to warrant protection under the ESA and (2) a recovery plan is needed to guide conservation and recovery of the lynx DPS.

1.1 Background

The Canada lynx is a North American wild cat that is most strongly associated with northern-latitude boreal forests (taiga) of Canada and Alaska (McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 373-374; Mowat *et al*. 2000, p. 272). It is a prey specialist and relies almost exclusively on adequate populations of its primary prey, the snowshoe hare (*Lepus americanus*), to support survival, reproduction, recruitment, and, therefore, population persistence (Ruggiero *et al*. 2000a, p. 110; Mowat *et al*. 2000, p. 270; Steury and Murray 2004, pp. 128, 136-138; USFWS 2005, p. 2; Interagency Lynx Biology Team [ILBT] 2013, pp. 30-34; 79 FR 54808-54809). Lynx survival and distribution is also influenced by snow conditions. It is generally restricted to areas that receive deep, powdery, and persistent snow that allows lynx, with their proportionately longer limbs and very large feet, to outcompete other terrestrial hare predators that are less efficient in such conditions (McCord and Cardoza 1982, pp. 748-749; Quinn and Parker 1987, p. 684; Buskirk *et al*. 2000a, pp. 89-94; Buskirk *et al*. 2000b, pp. 400-401; Ruggiero *et al*. 2000b, pp. 445–449; Hoving 2001, p. 75; Hoving *et al*. 2005, p. 744-749; Carroll 2007, entire; Gonzalez *et al*. 2007, entire; ILBT 2013, pp. 25-26; 79 FR 54809).

Lynx are generally considered secure, widespread, abundant, and distributed throughout most of their historical ranges in Canada and Alaska, which, combined, account for roughly 98 percent of the species' distribution. Lynx are distributed across approximately 5.5 million km^2 (2.1 million mi^2) in Canada (Environment Canada 2014, p. 2) and 534,454 km^2 (206,354 mi^2) in Alaska (University of Alaska Center for Conservation Science 2016, entire; Reimer 2016, *pers. comm.*). The southern peripheries of the boreal forest and the distributions of snowshoe hares and lynx extend into the northern contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729; Agee 2000, pp. 39-41; Aubry *et al*. 2000, pp. 379-382; Hodges 2000a, pp. 163-173; McKelvey *et al*. 2000a, pp. 242-253), where the six geographic units evaluated in this SSA represent the remaining 2 percent of the species' breeding distribution (approximately 131,168 km^2 [50,644 mi^2]; see Figure 1 and Table 2, below). Lynx populations in the DPS (as well as some others on the margin of the range in southern Canadian provinces) seem to function as peripheral subpopulations (islands) of a larger (mainland) metapopulation centered in north-central Canada (McKelvey *et al*. 2000b, p. 25; 68 FR 40077; also see 2.2 below). The demographic and genetic health and persistence of DPS populations are thought to be influenced by connectivity with, and immigration of lynx from, larger populations in Canada

(McKelvey *et al.* 2000b, pp. 21, 33; Schwartz *et al.* 2002, entire; 78 FR 59434, 59447; 79 FR 54815).

Lynx were documented historically in 24 of the Lower 48 States (McKelvey *et al.* 2000a, pp. 207-232), but records in many places are associated with cyclic "irruptions" of large numbers of lynx dispersing from southern Canada during the decline phase of 8- to 11-year snowshoe hare population cycles. Many of these occurrences were in anomalous habitats, and lynx were unable to persist and establish populations in most of these areas (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 242, 253; Aubry 2006, pp. 1-2; ILBT 2013, p. 23; see also section 2.3.2, below). Habitats capable of supporting persistent resident lynx populations in the contiguous U.S. occur over a much smaller geographic area that includes parts of the Northeast (primarily northern Maine), western Great Lakes (northeastern Minnesota), Rocky Mountains (northern Idaho, northwestern Montana; perhaps also parts of northeastern Washington, the Greater Yellowstone Area (GYA) of southwestern Montana and northwestern Wyoming, and parts of western Colorado), and the eastern Cascade Mountains of northern Washington (68 FR 40077-40080; USFWS 2005, p. 3; 79 FR 54806-54807; Lynx SSA Team 2016, pp. 6-7). Although uncertainty remains regarding the historical distribution of resident lynx in the contiguous U.S., and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial changes in population status in the contiguous U.S. has been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11; also see section 2.3.2, below).

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 14 states in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms on Federal lands (65 FR 16052). In 2003, in response to a court memorandum opinion on the 2000 listing rule, the Service reaffirmed its determination of the lynx DPS and its status as threatened under the ESA (68 FR 40076). The Service completed a recovery outline in 2005 (UUSFWS 2005, entire), designated critical habitat for the DPS in 2006 (71 FR 66008) and, in 2007, again in response to a court order, clarified its determinations of "significant portion of the range" and that all lynx in the contiguous U.S. constitute a single DPS (72 FR 1186). Also in 2007, the Service announced that it would initiate a 5-year status review of the DPS (72 FR 19549). The Service revised the critical habitat designation for the DPS in 2009 (74 FR 8616) and 2014 (79 FR 54782) and, concurrent with the latter, rescinded the state-based definition of the DPS boundary to formally extend ESA protection to lynx "where found" in the contiguous U.S., including New Mexico and other states that were not included in the original DPS range (79 FR 54804). The Service reinitiated the 5-year status review in 2015 (USFWS 2015, entire), and that review will be informed by this SSA report. On September 7, 2016, the U.S. District Court for the District of Montana remanded the 2014 critical habitat designation to the Service for further consideration (U.S. District Court MT 2016, entire).

The six geographic units evaluated in this SSA encompass all areas of the contiguous U.S. that currently support or are believed to have recently supported persistent resident lynx populations (Figure 1, above). Five of the six geographic units were designated as "Core Areas" in the

Recovery Outline (USFWS 2005, pp. 4-6, 21, 23), and western Colorado was designated a "Provisional Core Area" (USFWS 2005, pp. 6, 21, 23). With the exception of western Colorado, these units also encompass and closely mirror the areas the Service designated as critical habitat in 2014 (79 FR 54782). Some areas adjacent to but outside these geographic units are known or suspected to intermittently support lynx home ranges and occasional reproduction. Uncertainty remains as to whether resident lynx populations occurred historically in other areas not encompassed by the geographic units evaluated here.

The six geographic units include Federal, private, State, and Tribal lands. The amounts in each ownership vary among the units, with private lands predominating in Maine, a mix of ownerships in Minnesota, and Federal lands predominating in the western units (Table 2).

Table 2. Lynx SSA Unit Sizes and Percent Ownership.

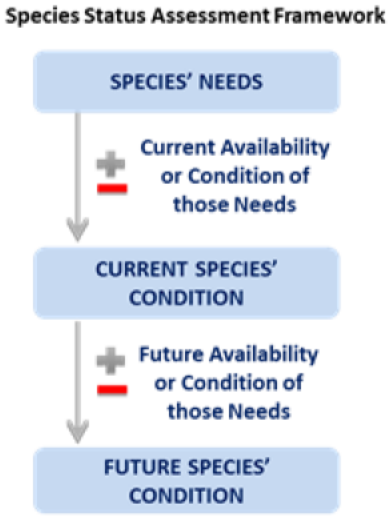
Unit[1]	Unit Size (km^2)	Percent of SSA Area	Land Ownership/Management (Percent)[2]						
			Federal[3]				Private	State	Tribal
			All Federal	USFS	NPS	BLM			
1	28,909	22.0	1.2	0	1.2	0	90.4	7.3	0.9
2	21,101	16.1	47.4	44.9	2.5	0.01	15.5	36.2	1.0
3	26,997	20.6	84.3	69.3	13.6	1.5	8.0	4.1	3.5
4	5,176	3.9	91.5	84.6	6.7	0.1	0.3	8.2	0
5	23,687	18.1	97.6	79.7	16.7	1.1	2.2	0.3	0
6	25,294	19.3	90.1	85.2	1.8	3.1	9.3	0.6	0
All Units	131,164	100	63.8	55.6	7.1	1.1	26.3	8.8	1.1

[1] Unit 1 - Northern Maine; Unit 2 - Northeastern Minnesota, Unit 3 - Northwestern Montana/ Northeastern Idaho, Unit 4 - North-central Washington, Unit 5 - the Greater Yellowstone Area (Southwestern Montana/Northwestern Wyoming), Unit 6 - Western Colorado.
[2] Unit sizes and ownership for units 1-5 are those calculated for the areas designated in 2014 as lynx critical habitat, including some Tribal, State and private lands that met the criteria for critical habitat but which were excluded from the designation in accordance with section 4(b)(2) of the Endangered Species Act. Unit 6 size and ownership were calculated by the Service's Western Colorado Field Office in coordination with Colorado Parks and Wildlife based on telemetry data from radio-marked lynx.
[3] USFS = U.S. Forest Service; NPS = National Park Service; BLM = Bureau of Land Management.

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1.2 SSA Framework and Report

The Service is engaged in a number of efforts to improve the implementation of the ESA (see http://www.fws.gov/endangered/improving_ESA/). As part of this effort, our Endangered Species Program has developed the Species Status Assessment (SSA) Framework to guide how we assess the best scientific and commercial data available when evaluating the biological status of species. In conducting an SSA, we take into consideration the life history and ecological requirements of the species to understand how the species maintains itself over time (captured under the broad heading of "species needs"); the current condition of the species at the individual, population, and range-wide levels in terms of meeting those needs; and the likely changes in the environment that may influence the species' future condition and, thus, the viability of the species.



The SSA Framework defines viability as a description of the ability of a species to sustain populations in the wild beyond a biologically meaningful time frame[1]. Throughout the assessment, the SSA uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3 Rs") as a lens to evaluate the current and future condition of the species. Briefly, resiliency describes the ability of the species to withstand stochastic events; redundancy describes the ability of the species to withstand catastrophic events; and representation describes the ability of the species to adapt over time to long-term changes in the environment. As a result, the SSA characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings. Importantly, the SSA neither results in, nor predetermines, any decisions (e.g., listing status, critical habitat designations, section 7 consultation requirements, etc.) by the Service under the ESA. Instead the SSA provides the biological basis to inform these decisions. The SSA is a dynamic document and should be periodically revised as new scientific information becomes available.

The Species Status Assessment Report (SSA Report) is a summary of the information assembled, reviewed, and assessed by the Service and is based on the best scientific and commercial data available at the time of the assessment. Completed SSA Reports and supporting material can be found at the collaborative repository of the National Park Service and the USFWS called "ServCat" at the following IP address: *http://www.fws.gov/Refuges/NaturalResourcePC/landM/serviceCatalog.html*.

[1] Viability is not a specific state, but rather a continuous measure of the likelihood that the species will sustain populations in the wild over time. USFWS. 2015. Species Status Assessment Framework. Version 3.3. October 2015.

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1.3 Analytical Approach/Methods

We used the SSA Framework (October 2015, version 3.3) described above to evaluate the current status of resident lynx in the contiguous U.S. as well as the likelihood that the geographic areas supporting resident lynx in the DPS would continue to do so in the near term and at mid- and end-of-century (years 2025, 2050, and 2100). We framed our evaluation in terms of the 3 Rs using conceptual modeling (Figures 2-5) based on available published literature, other information on the historical and current status of and threats to lynx in the DPS and, where empirical data are lacking, on formally-elicited expert opinion and best professional judgment (Lynx SSA Team 2016, entire).

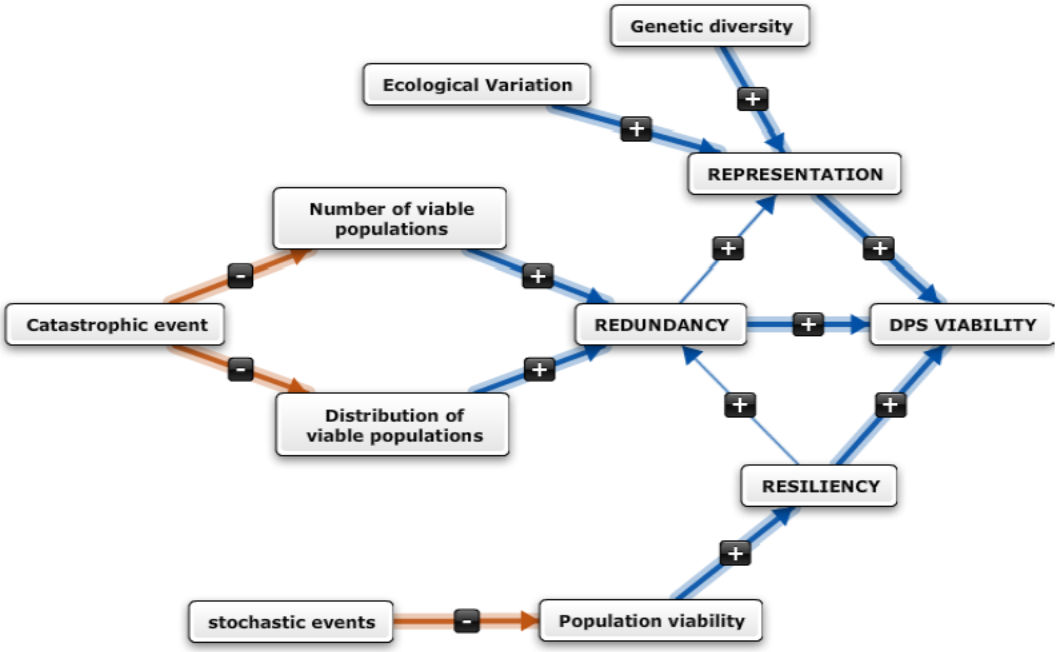


Figure 2. Conceptual model of the factors thought to influence the 3 Rs as they pertain to lynx viability.

We applied the definitions from the SSA Framework for the principles of redundancy, representation, and resiliency, provided in section 1.2, to Canada lynx as described below. We evaluated redundancy and representation at the scale of the DPS as a whole, and resiliency at the scale of lynx populations within each of the six geographic units.

To evaluate **redundancy** for the lynx DPS, we considered the current and likely future geographic distributions of resident breeding populations and whether the DPS is currently vulnerable to extirpation from a catastrophic event or would be vulnerable in the future. We consider catastrophic events to be relatively discrete in both time and geographic extent (e.g., wildfires, storms, floods, volcanic eruptions, etc.) and, therefore, we do not consider anthropogenic climate warming as a catastrophic event (see below). Figure 3 shows examples of relationships among factors that may influence redundancy within the lynx DPS.

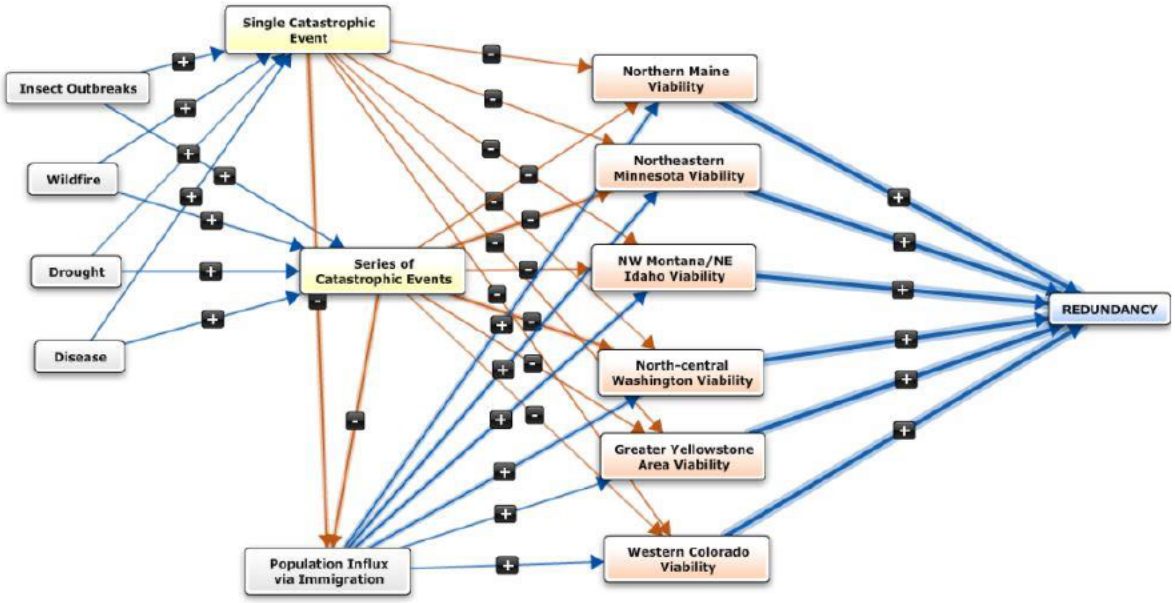


Figure 3. Conceptual model of factors thought to influence redundancy within the lynx DPS.

To evaluate **representation** for the lynx DPS, we considered measures of genetic diversity and heterozygosity, the current and likely future ecological diversity of geographic areas occupied by resident breeding populations, and the documented dispersal capabilities of the species, as shown in Figure 4 below.

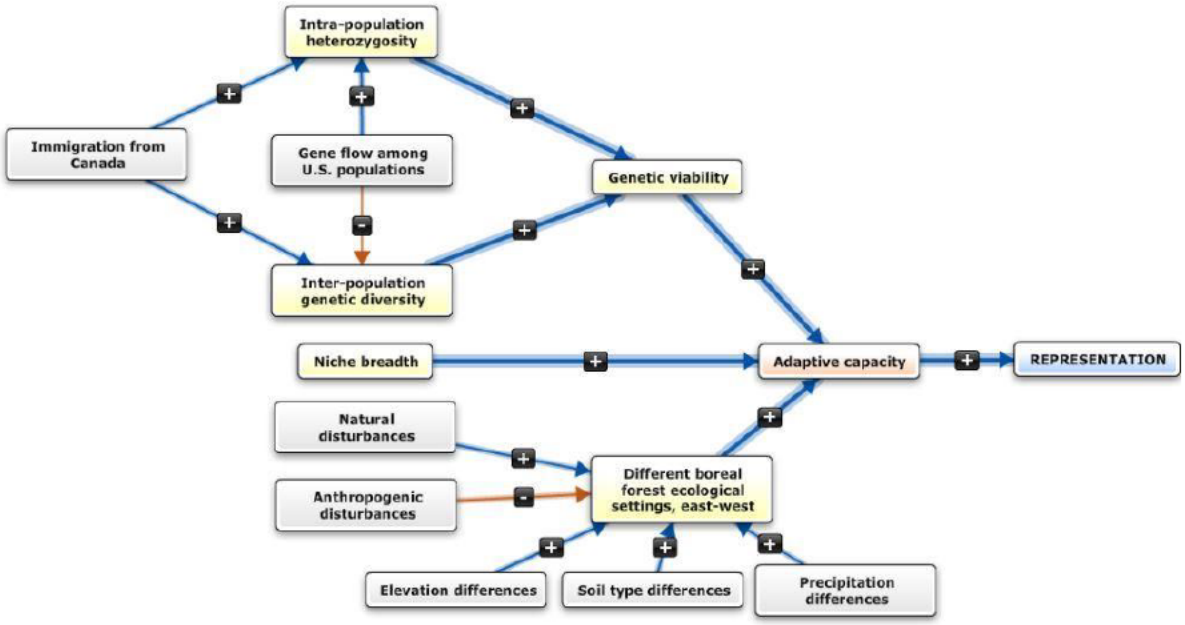


Figure 4. Conceptual model of factors thought to influence representation within the lynx DPS.

Because we lack reliable estimates of population sizes and trends, growth rates, and other long-term demographic data for most populations in the DPS, our evaluation of the **resiliency** of lynx populations in the DPS was based largely on consideration of recent status updates and formally-elicited expert opinion regarding the likelihood that DPS populations will remain viable into the future. The relationships among factors that influence DPS resiliency are shown in Figure 5 below.

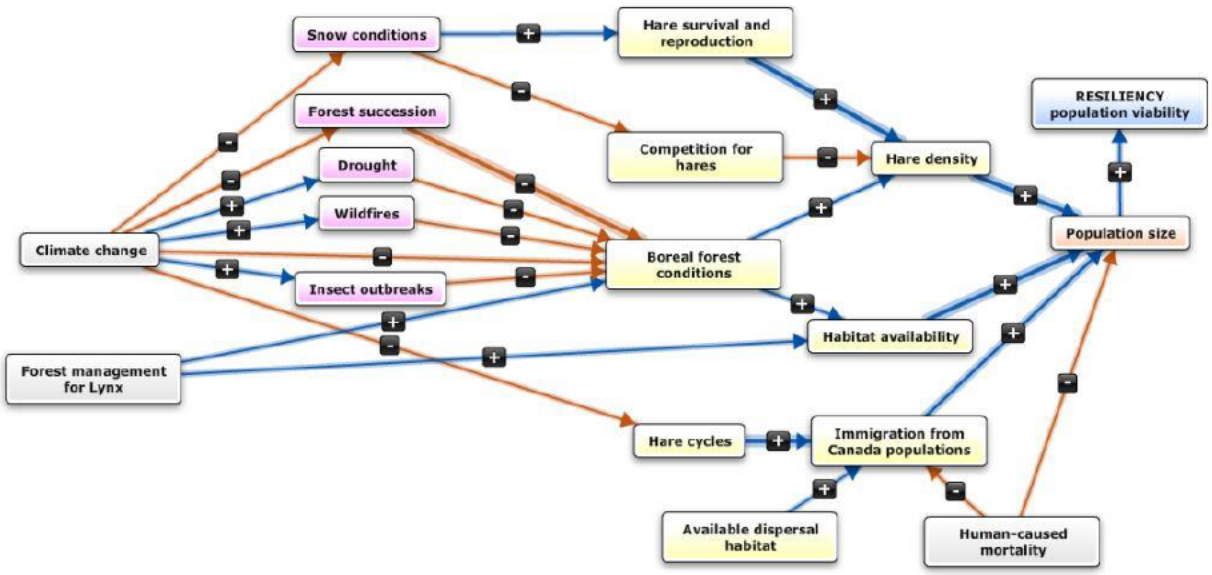


Figure 5. Conceptual model of factors thought to influence the resiliency of lynx populations within the DPS.

We elicited expert input on the probabilities that resident lynx populations will persist in each geographic unit because we lack reliable estimates of the sizes and trends of lynx populations in the DPS and because existing demographic data are inadequate to construct empirical models to project population sizes, trends, and viability into the future. In Chapter 5, we present summaries of experts' predictions regarding the probability of lynx persistence in each geographic unit; the factors they thought would most likely influence those probabilities; and the sources of uncertainty that influenced their confidence in their predictions. We then present our evaluation of the scientific literature regarding how certain anthropogenic factors may influence future conditions for resident lynx in each geographic unit. The factors we consider for each geographic unit include regulatory mechanisms (the factor for which the DPS was originally listed under the ESA) and the anthropogenic influences identified by the Interagency Lynx Biology Team (ILBT) as the most likely to have population-level impacts to lynx in the DPS (climate change, vegetation management, wildland fire management, and habitat loss/fragmentation; ILBT 2013, pp. 68-78). Other factors were also evaluated for some geographic units if the SSA Core Team member most familiar with that unit felt those factors could pose meaningful, even if less likely, risks to the unit's continued ability to support resident

lynx. After considering all of the above, we present our conclusions regarding the future conditions for resident lynx in each geographic unit and we discuss the extent to which our conclusions agree with or differ from the projections provided by the lynx expert panel we consulted and, if they differed, why.

Implicit in our evaluation of the future for lynx in the contiguous U.S. is our recognition and consideration of a future in which the DPS is not listed under the ESA. However, given the DPS's listing history and the ESA's requirements for delisting, we do not evaluate the unlikely hypothetical future in which the DPS is not listed and all protections and conservation efforts disappear. Rather, we assume that although some protections could be relaxed (e.g., less stringent analyses of Federal project-related impacts, potential for some states to reinstitute limited trapping/hunting harvest), that conditions for delisting would include requirements and incentives to continue to conserve lynx and its habitats and to assure persistence of resident lynx populations in those places that can support them on Federal, State and Tribal lands (perhaps some private lands as well). Our evaluation, therefore, considers the possibility of the future relaxing of some lynx conservation measures and efforts, but not the complete absence of all protections for lynx.

Additionally, we do not to define and evaluate specific and explicit climate change/ greenhouse gas emissions scenarios or attempt to quantify differences in DPS viability or the persistence of resident lynx populations in individual geographic units based on differences in the rate and extent of potential impacts associated with projected continued climate warming. This is because of the limited resolution and inherent uncertainty of available climate models and the inadequacy of existing demographic data for projecting lynx populations in the DPS over time, including their potential responses to a range of climate-mediated potential future habitat conditions. Therefore, this SSA does not constitute or include a formal climate change vulnerability assessment (Glick *et al*., editors, 2011, entire) for the lynx DPS. Instead, underlying our evaluation in this SSA is the recognition that the lynx, as a broadly-distributed boreal forest- and snow-reliant predator that relies heavily on a single, similarly-specialized prey species, and whose habitats are influenced by climate-mediated disturbance factors (e.g., wildfire, forest insects, wind/ice storms, etc.), is likely highly sensitive and broadly exposed to the impacts of climate change and has limited adaptive capacity to respond to it. Therefore, we (along with the experts we consulted and the ILBT) consider lynx populations in the DPS vulnerable to the projected impacts of continued climate warming. While we recognize that the pace and extent of impacts would be expected to differ under specific emissions or modeling scenarios, the limitations described above preclude us from quantifying those differences and their potential influence on the probabilities that resident lynx will persist in the DPS or in individual geographic units. Finally, in our analyses we do not consider anthropogenic climate warming a catastrophic effect because it is not temporally- and spatially-discrete; characteristics of events traditionally considered catastrophic (e.g., wildfires, floods, storms, volcanic eruptions, etc.). Rather, we consider climate warming as an ongoing, pervasive, and cumulative stressor of lynx and their habitats, particularly at the southern margin of the species' distribution, including all geographic areas of the DPS.

Chapter 2: Lynx Ecology

In this chapter, we describe the physical characteristics, taxonomy, and genetics of the Canada lynx, its life history and population dynamics, and its taxon-wide and DPS distributions. We rely heavily on recent summaries of this information provided in the revised *Canada Lynx Conservation Assessment and Strategy* (LCAS; ILBT 2013, entire), the Service's recent proposed (2013) and final (2014) rules to revise the designation of critical habitat for the DPS (78 FR 59430-59474; 79 FR 54782-54846), and the results of an October 2015 lynx expert elicitation workshop (Lynx SSA Team 2016, entire). We also provide a summary of the pertinent ecological requirements of lynx at the individual, population, and DPS levels. These ecological requirements form the basis of our analyses conducted in Chapters 3 through 5.

2.1 Species Taxonomy, Description, and Genetics

The Canada lynx (order Carnivora; family Felidae) is one of four species within the genus *Lynx* (Kerr 1792), which also includes the bobcat (*L. rufus*, Schreber 1777), the Eurasian lynx (*L. lynx*, Linnaeus 1758), and the Iberian or Spanish lynx (*L. pardinus*, Temminck 1827). There are three recognized subspecies of Canada lynx: *Lynx canadensis canadensis* (Kerr 1792), *L. c. mollipilosus* ("Arctic lynx," Stone 1900), and *L. c. subsolanus* ("Newfoundland lynx," Bangs 1897) (Integrated Taxonomic Information System online database, http://www.itis.gov, retrieved April 14, 2016).

The Canada lynx is a medium-sized cat with long legs and large, well-furred paws. In winter, the lynx's fur is dense and has a grizzled appearance with a grayish-brown mix of buff or pale brown fur on the back, and a grayish-white or buff-white fur on the belly, legs, and feet. In summer, its fur is more reddish to gray-brown (McCord and Cardoza 1982, p. 730). It has long tufts of black hairs extending from the tips of its ears, a short, completely black-tipped tail, and often a distinct dish-like facial ruff of pale hairs tipped black. Lynx generally measure 75 to 90 cm (30 to 35 in) long and weigh 6 to 14 kg (14 to 31 lb) (Quinn and Parker 1987, Table 1; Moen *et al.* 2010a, Figure 2; Maine Department of Inland Fisheries and Wildlife 2012, unpublished data), and males are 13-25 percent larger than females (Mowat *et al.* 2000, p. 267). The lynx's large feet and long legs make it highly adapted for traversing and hunting in deep, powdery snow, where its low foot-loading (weight per surface area of foot) is thought to provide a competitive advantage (Buskirk *et al.* 2000a, p. 90; 2000b, p. 400; ILBT 2013, pp. 26, 36, 81) over other terrestrial predators of snowshoe hares, the lynx's primary prey. In southern Canada and the northern contiguous U.S., where the southern edge of the lynx range overlaps the northern edge of the bobcat range, the two species are easily confused because of their similar size and appearance. However, the lynx's longer ear-tufts, larger feet, and black-tipped tail distinguish it from the bobcat, which has shorter ear tufts, small feet, and white on the underside of the tail. Bobcats are much more common and abundant than lynx in most of the contiguous U.S.

Overall, genetics research suggests high gene flow across most of the continental range of lynx, likely because of high dispersal rates, large dispersal distances, and the absence of significant

barriers to genetic interchange throughout much of the lynx range, including the DPS (Schwartz *in* Lynx SSA Team 2016, pp. 11-12). Genetic evidence also indicates interactions between lynx populations even where physical barriers appear most likely to restrict gene flow. For example, although *L. c. subsolanus* on Newfoundland Island is genetically (Row *et al.* 2012, pp. 1262-1266; Koen *et al.* 2015, p. 528) and morphologically (Khidas *et al.* 2013, pp. 597-601) distinct from mainland lynx (*L. c. canadensis*), there is evidence of genetic exchange between the two areas, indicating that some lynx are able to cross the 15-60 km-wide (9-37 mi) Strait of Belle Isle that separates them (Koen *et al.* 2015, p. 527). Similarly, despite some differences in functional genetic markers (unique alleles) in lynx south versus north of the St. Lawrence Seaway/River in eastern Canada, which suggest the potential for evolutionarily significant differences in those areas, recent analyses reveal genetic exchange among lynx on either side, indicating that some lynx successfully navigate this barrier (Koen *et al.* 2015, pp. 524-528; Bowman *in* Lynx SSA Team 2016, p. 12-13).

Schwartz *et al.* (2003, entire) documented reduced genetic variation (lower mean number of alleles per population and lower expected heterozygosity) among peripheral lynx populations compared to populations in the core of the lynx geographical range in Canada and Alaska. While recognizing that small changes in genetic variation can lead to large changes in population fitness, the authors noted that the differences between core and peripheral populations in their study were small enough to suggest a lack of significant population subdivision (i.e., no indication of genetic isolation, substantial genetic drift, or potential genetic "bottlenecks" among DPS populations; Schwartz *et al.* 2003, p. 1814; 79 FR 54793). This finding is consistent with their earlier work, which documented high levels of gene flow (the highest yet documented for any carnivore) between core and peripheral lynx populations despite large separation distances (Schwartz *et al.* 2002, entire). Their results did not suggest that reduced genetic variation among peripheral populations was because of human disturbance (i.e., habitat loss/ fragmentation on the southern periphery of the geographic range; Schwartz *et al.* 2003, p. 1814), but they did imply that the persistence of lynx populations in the contiguous U.S. depends on dispersal from larger (core) populations (Schwartz *et al.* 2002, p. 522).

Currently, there is no indication that the levels of connectivity and gene flow between lynx populations in the DPS and those in the core of the lynx's range are inadequate to maintain the genetic health of DPS populations. Given the connectivity of most DPS units with lynx populations and habitats in Canada, the noted dispersal capabilities of lynx, evidence of dispersal in both directions across the Canada-U.S. border (Aubry *et al.* 2000, pp. 386-387; Squires *et al.* 2006a, p. 38; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and the small number of immigrants thought necessary to maintain genetic variability in peripheral populations (McKelvey *et al.* 2000b, pp. 23-24), genetic isolation, biologically meaningful genetic drift, or potential genetic "bottlenecks" appear unlikely among most DPS populations in the future (79 FR 54793).

Within the contiguous U.S., minor genetic sub-structuring has been documented among lynx subpopulations in western Montana (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5).

Genetic diversity may be somewhat greater among lynx in western Colorado than elsewhere in the DPS range because of the broad geographic distribution of the source populations that contributed to the lynx releases in Colorado (45 lynx from Quebec, four from Manitoba, 91 from British Columbia, 48 from The Yukon Territory, and 30 from Alaska). Additionally, lynx-bobcat hybridization has been documented in Minnesota, Maine and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where male bobcats bred with female lynx to produce fertile offspring with lynx-like ear tufts, intermediate foot-size, and bobcat-like fur (ILBT 2013, p. 35). In Minnesota from 2000 to 2015, DNA analyses documented 13 distinct hybrid individuals (Moen and Catton *in* Lynx SSA Team 2016, pp. 13, 19); no hybrids have been documented in the western portion of the lynx's range (Schwartz *in* Lynx SSA Team 2016, p. 12).

2.2 Life History and Population Dynamics

All aspects of lynx life history are inextricably tied to its primary prey, the snowshoe hare (Figure 6). Snowshoe hares comprise a majority of the lynx diet throughout its range (Nellis *et al.* 1972, pp. 323–325; Brand *et al.* 1976, pp. 422–425; Koehler 1990, p. 848; Apps 2000, pp. 358–359, 363; Aubry *et al.* 2000, pp. 375–378; Mowat *et al.* 2000, pp. 267–268; von Kienast 2003, pp. 37–38; Squires *et al.* 2004a, p. 15, Table 8, Olson 2015, pp. 60-69), and hare abundance is the major driver of lynx population dynamics. Lynx den site selection, litter sizes, pregnancy, as well as recruitment, survival (kitten, subadult and adult) and dispersal rates, and population age structure, home range sizes, density, and distribution are all strongly influenced by hare abundance (Koehler and Aubry 1994, pp. 75-76, 80-83; Apps 2000, entire; Aubry *et al.* 2000, pp. 375-390; Mowat *et al.* 2000, pp. 270-294; ILBT 2013, pp. 18, 22-24, 26-34).

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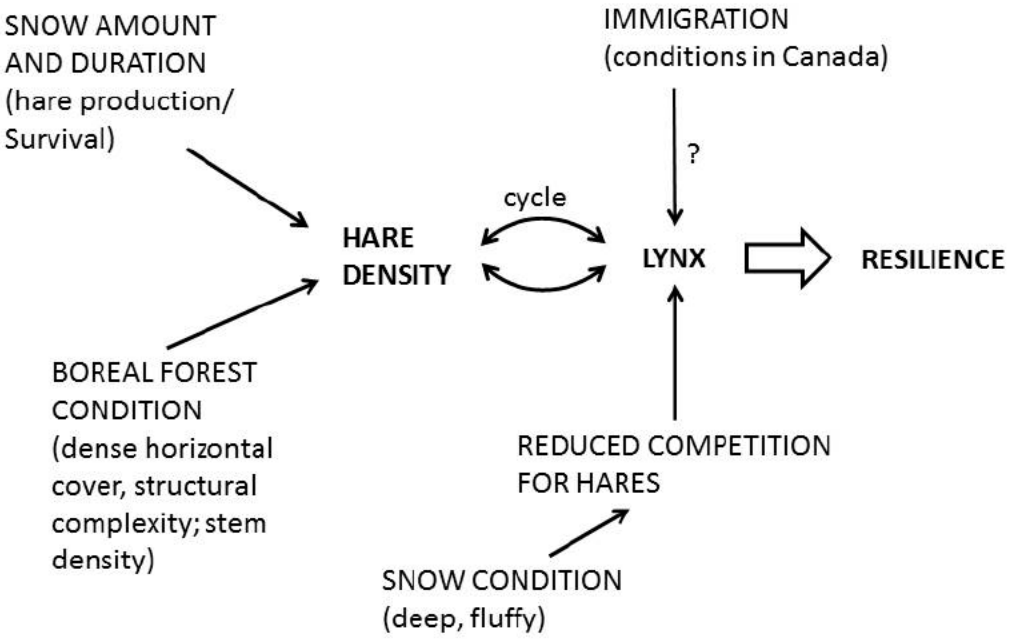


Figure 6. Generalized relationship between habitat conditions and hare and lynx population dynamics and their influence on lynx population resiliency.

Lynx are highly specialized predators of snowshoe hares and are dependent on landscapes with high-density snowshoe hare populations for survival and reproduction (McCord and Cardoza 1982, p. 744; Quinn and Parker 1987, pp. 684-685; Aubry *et al.* 2000, pp. 375-378). Lynx and snowshoe hares are strongly associated with what is broadly described as boreal forest (Bittner and Rongstad 1982, p. 154; McCord and Cardoza 1982, p. 743; Quinn and Parker 1987, p. 684; Agee 2000, p. 39; Aubry *et al.* 2000, pp. 378-382; Hodges 2000a, pp. 183-191 and 2000b, pp. 136-140; McKelvey *et al.* 2000a, pp. 211-232). The predominant vegetation of boreal forest is conifer trees, primarily species of spruce (*Picea* spp.) and fir (*Abies* spp.) (Elliot-Fisk 1988, pp. 34-35, 37-42). Snowshoe hares feed on conifers, deciduous trees, and shrubs (Hodges 2000a, pp. 181-183) and are most abundant in forests with dense understories that provide forage, cover to escape from predators, and protection during extreme weather (Wolfe *et al.* 1982, pp. 665-669; Litvaitis *et al.* 1985, pp. 869-872; Hodges 2000a, pp. 183-195 and 2000b, pp. 136-140). Over much of the lynx's range, hare densities are higher in regenerating, earlier successional forest stages because they often have greater understory structure than mature forests (Buehler and Keith 1982, p. 24; Wolfe *et al.* 1982, pp. 665-669; Koehler 1990, pp. 847-848; Hodges 2000a, pp. 183-195; Homyack 2003, pp. 63, 141; Griffin 2004, pp. 84-88). However, snowshoe hares also can be abundant in mature forests with dense

understories, particularly in the Northern Rocky Mountains (Griffin 2004, pp. 53-54; Griffin and Mills 2009, pp. 1492-1496; Hodges *et al.* 2009, p. 876; Squires *et al.* 2010, pp. 1653-1657; Berg *et al.* 2012, pp. 1483-1487). These mature forests may be a source of hares for other adjacent forest types (Griffin and Mills 2009, pp. 1492, 1495-1496), and they may provide especially important winter foraging habitats (Squires *et al.* 2010, pp. 1655-1657), which may be the most limiting habitat for lynx (Squires *et al.* 2010, pp. 1655-1657; ILBT 2013, pp. 17, 27). They also are more temporally-stable (i.e., they provide high-quality hare habitat for a longer period of time) than regenerating stands, which may foster high hare densities for a variable window of time between stand-initiation and stem-exclusion stages of succession, after which they may persist, in the absence of disturbance, for many years as lower-quality hare habitat (ILBT 2013, pp. 62, 71, 127).

Lynx habitat can generally be described as moist boreal forests that have cold, snowy winters and a snowshoe hare prey base (Quinn and Parker 1987, pp. 684-685; Agee 2000, pp. 39-47; Aubry *et al.* 2000, pp. 373-375; Buskirk *et al.* 2000b, pp. 397-405; Ruggiero *et al.* 2000b, pp. 445-447). Because lynx population dynamics, survival, and reproduction are closely tied to snowshoe hare availability, snowshoe hare habitat is the primary component of lynx habitat. However, lynx do not occur everywhere within the range of snowshoe hares in the contiguous U.S. (Bittner and Rongstad 1982, p. 146; McCord and Cardoza 1982, p. 729). This may be due to inadequate abundance, density, or spatial distribution of hares in some places, or the absence of snow conditions that would allow lynx to express a competitive advantage over other hare predators, or a combination of these factors (79 FR 54809).

The boreal forest landscape is naturally dynamic. Forest stands within the landscape change as they undergo succession after natural or human-caused disturbances such as fire, insect epidemics, wind, ice, disease, and forest management (Elliot-Fisk 1988, pp. 47-48; Agee 2000, pp. 47-69). As a result, lynx habitat within the boreal forest landscape is a shifting mosaic of habitat patches of variable and continually changing quality (68 FR 40077). These stands of differing ages and conditions provide lynx foraging or denning habitat (or may provide these in the future depending on patterns of disturbance and forest succession), and some serve as travel routes for lynx moving between foraging and denning habitats (McKelvey *et al.* 2000c, pp. 427-434; Hoving *et al.* 2004, pp. 290-292). Lynx generally concentrate hunting activities in areas where snowshoe hare densities are high (Koehler *et al.* 1979, p. 442; Ward and Krebs 1985, pp. 2821-2823; Murray *et al.* 1994, p. 1450; O'Donoghue *et al.* 1997, pp. 155, 159-160 and 1998, pp. 178-181; Fuller and Harrison 2010, entire; Simons-Legaard *et al.* 2013, pp. 573-575). Because understory density within a forest stand changes over time, hare habitat quality and corresponding hare densities also shift continually across boreal forest landscapes.

Hare populations in the core of the lynx range in Canada and Alaska undergo well-documented dramatic 8 to 11 year cycles during which hare numbers may fluctuate 10 to 25 fold or more, with peak densities as high as 23 hares/hectare (ha; 9.3 hares/acre [ac]) and lows of 0.1/ha (0.04/ac) (Hodges 2000b, pp. 117-121; Vashon 2015, p. 4). Hare densities are generally lower at the southern periphery of lynx distribution, and hare population cycles are generally much less pronounced or absent entirely among some hare populations in southern Canada and in

the contiguous U.S. (Hodges 2000a, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17). In the contiguous U.S., average stand-level hare densities may exceed 2 hares/ha (0.8 hares/ac) (Walker 2005, pp. 20, 85; McCann 2006, p. 15; Robinson 2006, pp. 26-36, 62-75; Homyack *et al.* 2007, pp. 10-11; Griffin and Mills 2009, p. 1492; Vashon *et al.* 2012, p. 14), but in many parts of the DPS, landscape-level densities are lower, ranging from just above to well below the 0.5 hares/ha (0.2/ac) density thought necessary to sustain lynx home ranges and populations (Hodges 2000a, pp. 168-169, 185; Ruggiero *et al.* 2000b, pp. 446–447; Squires and Ruggiero 2007, pp. 313-314; Maletzke *et al.* 2008, pp. 1476-1477; Zahratka and Shenk 2008, pp. 910-911; Hodges *et al.* 2009, pp. 873-877; Ivan 2011a, pp. 91-92, 95-102; Berg *et al.* 2012, p. 1483; ILBT 2013, pp. 24, 26, 90).

During lows in snowshoe hare populations, lynx prey opportunistically on other small mammals, especially red squirrels (*Tamiasciurus hudsonicus*), and birds, but alternate prey species do not sufficiently compensate for low availability of snowshoe hares, and lynx populations cannot persist over time in areas with consistently low hare densities (Brand *et al.* 1976, pp. 422–425; Brand and Keith 1979, pp. 833–834; Koehler 1990, pp. 848–849; Mowat *et al.* 2000, pp. 267–268). Nonetheless, even in areas with relatively low or marginal hare densities, hares constitute the majority of the biomass in lynx diets (Koehler and Aubry 1994, p. 85; Apps 2000, pp. 362-363; Aubry *et al.* 2000, pp. 375-378; Roth *et al.* 2007, pp. 2740-2741; Squires and Ruggiero 2007, pp. 310-313; Hanson and Moen 2008, p. 9; Maletzke *et al.* 2008, pp. 1475-1477; Shenk 2009, pp. 13, 16; Ivan *in* Lynx SSA Team 2016, Appendix 3, pp. 13-14).

Lynx typically mate in March and April, and kittens are born from late April to mid-June after a 60- to 70-day gestation period (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Female lynx typically reach reproductive maturity in their second year (at 22 months of age); however, when hares are abundant, females may breed at 10 months of age and produce kittens as 1-year-olds (Koehler and Aubry 1994, p. 81; Mowat *et al.* 2000, p. 285). Males do not seem to breed as yearlings, and they do not contribute to rearing of young (ILBT 2013, p. 30). Lynx dens are typically located in areas of dense cover, where coarse woody debris, such as downed logs and windfalls, provides security and thermal cover for lynx kittens (McCord and Cardoza 1982, pp. 743-744; Koehler 1990, pp. 847-849; Slough 1999, p. 607; Squires and Laurion 2000, pp. 346-347; Organ *et al.* 2008, entire; Squires *et al.* 2008, pp. 1497, 1501-1505; Moen and Burdett 2009, entire). Dens have been documented in both mature and younger boreal forest stands (Mowat *et al.* 2000, pp. 274-275; Squires *et al.* 2008, p. 1497; ILBT 2013, pp. 29-30; 78 FR 59441-59442; 79 FR 54809-54810; Organ *et al.* 2008, entire), and the amount of structure (e.g., downed, large, woody debris, tip-up mounds) seems to be more important than the age of the forest stand for lynx denning habitat (Mowat *et al.* 2000, pp. 274-275, Organ *et al.*2008, p. 1516). Denning habitat is not thought to be a limiting factor for lynx in the DPS (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517; Squires *et al.* 2008, p. 1505; ILBT 2013, p. 30; 79 FR 54790). Dens must be near foraging habitat to allow females to adequately provision dependent kittens, and females seem to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). Females attend kittens at the natal den site and

one or more (up to five) alternate or maternal dens until kittens are about 6-10 weeks old (Squires *et al.* 2008, p. 1502; Olson *et al.* 2011, pp. 458-460; Vashon *et al.* 2012, p. 17; ILBT 2013, p. 29). Thereafter, kittens remain with their mothers through their first winter, apparently learning from her how to hunt and capture prey, initially on a small portion of her home range, but by fall on the larger area the female used before kittens were born (Mowat *et al.* 2000, pp. 269, 278). Juveniles remain closely associated with their mothers until February or March, when family groups begin to break up, with young typically dispersing in April and May (Mowat *et al.* 2000, pp. 278-279) to establish their own home ranges. Female offspring may establish home ranges overlapping or adjacent to their mother's home range and maintain mother-daughter bonds throughout their lives (Mowat *et al.* 2000, pp. 279-280). Male home ranges may slightly overlap adjacent male home ranges. While male home ranges typically overlap one to three female home ranges, and female home ranges are partially or completely encompassed by a male's home range, core areas within home ranges appear to be exclusive except during the breeding season (Koehler and Aubry 1994, pp. 90-91; Mowat *et al.* 2000, pp. 276-280; Vashon *et al.* 2012, pp. 17, 22-23). Fidelity to home ranges over several years has been documented for both sexes, but shifts and abandonment of home ranges have also been documented (Koehler and Aubry 1994, p. 91; Mowat *et al.* 2000, p. 277). Lynx have been documented to live up to 16 years in the wild (Kolbe and Squires 2006, entire).

Lynx populations in Canada fluctuate in response to the cycling of hare populations (Elton and Nicholson 1942, pp. 241–243; Hodges 2000b, pp. 118–123; Mowat *et al.* 2000, pp. 265–272), with synchronous fluctuations in lynx numbers emanating from the core of the Canadian population and spreading over vast areas, generally lagging hare numbers by one year (McKelvey *et al.* 2000a, pp. 232, 239; Mowat *et al.* 2000, pp. 266, 270). When hares are abundant, lynx have higher pregnancy rates and larger litter sizes, higher kitten survival, and lower adult mortality, resulting in rapid population growth during the increase phase of the hare cycle (Slough and Mowat 1996, pp. 955–956; Mowat *et al.* 2000, pp. 266, 270–272, 281–289). When hare populations are low, female lynx produce few or no kittens that survive to independence (Nellis *et al.* 1972, pp. 326–328; Brand *et al.* 1976, pp. 420, 427; Brand and Keith 1979, pp. 837–838, 847; Poole 1994, pp. 612–616; Slough and Mowat 1996, pp. 953–958; O'Donoghue *et al.* 1997, pp. 158–159; Aubry *et al.* 2000, pp. 388–389; Mowat *et al.* 2000, pp. 285–287). When hares decline, lynx mortality rates increase, largely because of starvation, and home range sizes and dispersal/ emigration rates also increase (Ward and Krebs 1985, pp. 2821–2823; O'Donoghue *et al.* 1997, pp. 156, 159; Poole 1997, pp. 499–503; Mowat *et al.* 2000, pp. 265–272, 278, 281–294). Lynx numbers decline dramatically during the "crash" phase of the hare cycle (Slough and Mowat 1996, p. 956; Mowat *et al.* 2000, pp. 283-285), when many lynx starve and many others abandon home ranges and disperse in search of food, with many of the latter also dying, often soon after initiating dispersal (Mowat *et al.* 2000, p. 293).

In Canada, lynx abundance may be 3 to 17 times higher at the peak versus the low of the hare cycle, with lynx densities reaching 30-45/100 km^2 (78-117/100 mi^2) in optimal dense regenerating forests 15-40 years post-fire, 8-20/100 km^2 (21-52/100 mi^2) in older forests or further south, and < 3/100 km^2 (< 8/100 mi^2) at the hare cycle low (Slough and Mowat 1996, pp.

952, 955; Mowat *et al.* 2000, p. 283; Hatler and Beal 2003, pp. 2, 5; Environment Canada 2014, p. 1). In southern Canada, where hares are less abundant and hare population cycles are muted or absent, lynx populations may be stable at 2-3/100 km^2 (5-8/100 mi^2) (Environment Canada 2014, p. 1). Lynx densities estimated in the contiguous U.S. have ranged from 9.2-13/100 km^2 (24-34/100 mi^2), including kittens, in Maine's highest-quality habitat when hares were abundant (Vashon *et al.* 2008a, pp. 1483-1484; Vashon *et al.* 2012, pp. 14-15) to 2.3/100 km^2 (6/100 mi^2) in Washington when hare abundance was low (Koehler 1990, pp. 847-850). Correspondingly, hare abundance may also influence lynx home range size. Ward and Krebs (1985, pp. 2819-2820) documented a 3-fold increase in home range size in southwestern Yukon, from 13 km^2 (5 mi^2) on average when hares were abundant and increasing to 39 km^2 (15 mi^2) when hare density was low. Poole (1994, pp. 613-614) documented a similar trend in the Northwest Territories, where lynx home range size increased from 17 km^2 (7 mi^2; males and females combined) when hares were abundant, to 44 km^2 (17 mi^2) and 62 km^2 (24 mi^2) for males and females, respectively, when hare numbers declined. In contrast, Breitenmoser *et al.* (1993, p. 552) reported no change in lynx home range size despite a 10-15 fold increase in lynx density as hare abundance increased in the southern Yukon. Similarly, in Maine, lynx home range size did not increase when hare densities in the best habitats declined from 2/ha (0.8/ac) to 1/ha (0.4/ac) (Mallett 2014, pp. 53-93). In general, hare and lynx densities are lower and lynx home ranges larger at the southern periphery of the lynx's range, including most of the contiguous U.S., and are similar to those of northern populations during the low phase of the hare population cycle (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367).

Lynx populations in the contiguous U.S. seem to function as subpopulations or southern extensions of larger populations in northern and eastern Canada (McKelvey *et al.* 2000b, pp. 21, 25, 33; 65 FR 16052–16082; 68 FR 40077–40099; 71 FR 66025–66035; 74 FR 8616–8641; Koen *et al.* 2015, pp. 527-528). Populations in the DPS are relatively isolated from one another, though most are directly connected via dispersal to lynx populations in Canada (McKelvey *et al.* 2000b, pp. 25-34; U.S Fish and Wildlife Service 2005, p. 2). Lynx disperse in both directions across the Canada–U.S. border (Aubry *et al.* 2000, pp. 386-387; Moen *et al.* 2010b, pp. ii, 17, 19; Vashon *et al.* 2012, p. 22), and this connectivity and interchange with lynx populations in Canada is thought to be important to the conservation of lynx populations in the DPS. (McKelvey *et al.* 2000b, p. 33; Schwartz *et al.* 2002, p. 522; U.S Fish and Wildlife Service 2005, p. 2; ILBT 2013, p. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187). However, whether and, if so, to what the extent the demographic and genetic health and persistence of populations in the DPS depend on regular or intermittent immigration of lynx from Canada remains uncertain (McKelvey *et al.* 2000a, pp. 241-242; 79 FR 54793).

2.2.1 Ecological Requirements of Individuals

At the most fundamental level, the needs of an individual lynx are met if:

1) it is born to a female that occupies a home range containing
    a) secure denning habitat,

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b) adequate hare abundance to support lactation during the early kitten stage and later provisioning of the kitten with hare meat,
c) habitat (boreal forest and snow) conditions that reduce the likelihood and effect of competition from other hare predators, and
d) a low likelihood of encounters with lynx mortality agents (predators, trappers, vehicles, etc.);

2) the mother's home range occurs within a larger landscape that also contains adequate hare abundance and available habitat into which the yearling lynx may disperse and establish its own home range after the period of maternal dependence, with low likelihood of adverse competition and mortality; and

3) the larger landscape also supports other secure lynx home ranges and ensures the opportunity to encounter a lynx of the opposite sex, breed successfully, and contribute to the recruitment of at least one offspring into the breeding population during its lifetime.

In cyclic northern lynx populations, there is a strong element of timing that determines whether these individual needs will be met. During the decline and low phases of the hare population cycle, few kittens are born, very few survive until their first winter, and recruitment may collapse completely or nearly so for several successive years (Slough and Mowat 1996, entire; Mowat *et al.* 2000, pp. 266, 285-287). Therefore, even in the core of the species' range, a kitten born during a period of declining or low hare abundance is very unlikely to survive to independence, breed successfully, and replace itself within the breeding population in its lifetime. Conversely, a kitten born during the increase or high phase of the hare population cycle is much more likely to survive, establish a home range, breed successfully, and replace itself via recruitment of one or more of its offspring into the breeding population.

In southern lynx populations (southern Canada and the contiguous U.S.), hare population cycles are of lower amplitude or absent (Hodges 2000a, pp. 163–173; Hodges *et al.* 2009, pp. 870, 875–876; Scott 2009, pp. 1–44; Environment Canada 2014, p. 1; Hodges *in* Lynx SSA Team 2016, pp. 16-17), and hare and lynx abundances and lynx demographic rates are typically like those of northern populations during hare lows (Koehler and Aubry 1994, p. 93; Aubry *et al.* 2000, pp 382-385; Apps 2000, pp. 362-367). Therefore, the likelihood that an individual lynx will have its ecological requirements met sufficiently so that it may replace itself in the breeding population is probably consistently relatively low, perhaps similar to lynx born during hare declines/lows in the north. Also in the south, there are more diverse assemblages of potential competitors and predators, more natural patchiness and anthropogenic fragmentation of lynx habitat (fewer areas with adequate hare densities and favorable snow conditions distributed broadly across large landscapes), and higher road densities and, thus, greater potential for lynx-vehicle collisions (Wolff 1980, p. 128; Buskirk *et al.* 2000a, entire). These factors probably further reduce the likelihood that an individual lynx in the southern periphery of the range will survive, reproduce successfully, and have one or more offspring recruited into the resident breeding population.

Individual lynx require large areas of boreal forest landscapes to support their home ranges, provide hares in adequate abundance to meet their nutritional needs, provide breeding opportunities, and facilitate dispersal and exploratory travel. Female home ranges must also provide secure denning habitat in close proximity to foraging areas with high hare densities to allow females to adequately provision dependent kittens, and females appear to select den sites near prey sources to minimize time spent away from kittens while foraging (Moen *et al.* 2008a, p. 1507; Vashon *et al.* 2012, p. 16; ILBT 2013, p. 29). The size of lynx home ranges is strongly influenced by the quality of the habitat, particularly the abundance of snowshoe hares, in addition to other factors such as gender, age, season, and density of the lynx population (Aubry *et al.* 2000, pp. 382–385; Mowat *et al.* 2000, pp. 276–280). Generally, females with kittens have the smallest home ranges, likely related to their need to stay close to dens and dependent kittens, and males have the largest home ranges (Moen *et al.* 2005, p. 11; Burdett *et al.* 2007, p. 463; ILBT 2013, p. 24).

The increased natural patchiness and fragmentation of high-quality hare habitat where boreal forest conditions transition to temperate forest types require individual lynx in many parts of the DPS to maintain relatively large home ranges that include patches of higher hare densities within a matrix of lower-quality habitats with lower hare densities (ILBT 2013, p. 126; 78 FR 59434; also see 2.3.3, below). Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation and other mortality factors than lynx face in the core of their range (78 FR 59438). Annual home range sizes reported for lynx in the contiguous U.S. (Table 3, below) vary greatly across the DPS but are generally larger in the west than the east; however, differences should be interpreted with caution because different methods, sample sizes, and estimators were used to generate them (ILBT 2013, pp. 23-24).

Table 3. Reported annual home range sizes for Canada lynx in the contiguous United States.

Geographic Unit	Mean or Median Annual Lynx Home Range Size km^2 (Range)		References (Page Nos.)
	Female	Male	
N Maine	25-33 (14-70)	39-60 (24-102)	Vashon *et al.* 2008a (1482); Mallett 2014 (169)
NE Minnesota	17-87 (13-122)	160-267 (86-439)	Mech 1980 (263-265); Burdett *et al.* 2007 (460-463); Moen *et al.* 2008a (17)
NW Montana/ NE Idaho	43-90 (11-157)	122-220 (29-552)	Brainerd 1985 (20); Squires and Laurion 2000 (343-344); Squires *et al.* 2004a (13, Table 6)
N-C Washington	37-91 (37-91)	49-69 (29-99)	Brittell *et al.* 1989 *in* Stinson 2001 (5); Koehler 1990 (847); Maletzke *in* Lynx SSA Team 2016 (21)

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GYA	50-105 (32-105)	116-824 (98-2,181)	Squires and Laurion 2000 (343-344); Squires *et al.* 2003 (12-13)
W Colorado	75-704 (NA)	103-387 (NA)	Shenk 2008 (10)

Juvenile and adult lynx require about 400 and 600 grams (14 and 21 ounces) of food per day (for adults, 0.4-0.5 hares/day, 170-200 hares/year), respectively, to meet their basic nutritional requirements (Saunders 1963, p. 390; Nellis *et al.* 1972, pp. 324-325). Available research suggests that landscape-level hare densities >= 0.5 hares/ha (0.2/ac) are necessary to support lynx home ranges and resident breeding populations; lynx home range abandonment, dispersal, and mortality increase when hare densities are lower; and lynx may be unable to survive where landscape hare densities are below 0.3/ha (0.12/ac) (Ward and Krebs 1985, pp. 2819-2822; Slough and Mowat 1996, entire; Ruggiero *et al.* 2000b, pp. 446-447; ILBT 2013, pp. 26, 125). Recent research in the contiguous U.S. supports this - in northern Maine, areas with landscape hare densities of 0.74/ha (0.30/ac) supported resident breeding lynx, but areas with hare densities below 0.5/ha (0.2/ac) were not occupied by lynx (Simons-Legaard *et al.* 2013, pp. 567, 574-575). Likewise, in northeastern Minnesota, resident lynx maintained home ranges where landscape hare densities were 0.64/ha (0.26/ac), but nearby Voyageurs National Park, where hare density was estimated at 0.35/ha (0.14/ac), did not support resident breeding lynx (Moen *et al.* 2012, pp. 352–354).

In addition to adequate hare density, individual lynx require landscapes in which they are unlikely to encounter other species that may prey on them (mountain lion [*Puma concolor*], coyote [*Canis latrans*], wolverine [*Gulo gulo*], gray wolf [*Canis lupus*], and fisher [*Pekania pennanti*]) (ILBT 2013, pp. 33, 35). Although lynx have co-evolved with other predators, the influence of predation on lynx populations is unknown (ILBT 2013, pp. 35-36), and mountain lions and coyotes are now more widespread and abundant in the southern periphery of the lynx distribution than they seem to have been historically (Buskirk *et al.* 2000a, p. 83; Gompper 2002, entire). Lynx also need landscapes where they are unlikely to suffer reduced fitness because of competition with other hare predators, or encounter traps or other anthropogenic causes of mortality. Except for fisher and marten (*Martes americana*), lynx predators and potential terrestrial competitors for hares (the species above plus bobcat; maybe red fox [*Vulpes vulpes*] in some situations) all have higher foot-loading (weight per surface area of the foot), making them less efficient at traveling and hunting in the deep powdery snow conditions favorable for lynx (Buskirk *et al.* 2000a, pp 86-95, Krohn *et al.* 2005, entire) and, therefore, likely limiting, at least seasonally, interactions between lynx and these species. Analysis of lynx occurrence data in the contiguous U.S. suggests that lynx require at least four months (December through March) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Where snow conditions do not consistently favor lynx, increased potential for predation and competition would be expected (Peers *et al.* 2013, p. 8). Finally, individual lynx are more likely to survive, breed, and replace themselves in the breeding population if they occupy home ranges where trapping is prohibited or trapping pressure is low (Slough and Mowat 1996, entire), high-speed/ high-volume roadways are absent (ILBT 2013, pp. 77-78), and other potential anthropogenic causes of lynx mortality are minimal.

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In summary, individual lynx require large landscapes with hare densities that maximize their chances of (1) surviving to independence, (2) establishing and maintaining a home range, (3) breeding successfully, and (4) contributing genes to future generations (Breitenmoser *et al.* 1993, p. 552). These landscapes also must provide conditions that allow lynx to compete sufficiently for hares and minimize the likelihood of predation and other sources of lynx mortality. The available science suggests that landscape-level hare densities consistently >= 0.5 hares/ha (0.2/ac) and favorable snow depth and conditions for about four months are needed to support lynx occupancy, reproduction, and recruitment. At the southern periphery of lynx distribution, some places, including within the range of the DPS, seem to be at minimum thresholds to meet these requirements or do so inconsistently.

2.2.2 Ecological Requirements of Populations and the DPS

Lynx populations require essentially the same things that individual lynx do (see Figure 5 and section 2.2.1, above), but on a larger landscape with hare densities and habitat conditions capable of consistently supporting multiple home ranges, breeding and dispersal opportunities, and reproductive and survival rates such that recruitment and immigration will, on average over the long term, equal or exceed mortality and emigration (Pulliam 1988, pp. 652-654). To support persistent lynx populations, such landscapes must provide for the survival of at least some resident lynx even when hares are least abundant and/or other habitat features (e.g., snow conditions) are least favorable so that the lynx population can recover, perhaps aided by immigration, when hare numbers and/or other habitat conditions improve. As with individual lynx, populations are more likely to persist in landscapes where the effects of competition, predation, and human-caused mortality (e.g., trapping, vehicle collisions) are relatively lower.

In a mainland-island metapopulation structure like that thought to govern lynx population dynamics, the persistence of peripheral island populations is determined by colonization and extinction rates (McKelvey *et al.* 2000b, p. 25). Colonization is driven by the number of islands, the distances between them, and the species' dispersal capabilities and timing. Extinction rates are determined by population size and demographic and environmental stochasticity, with extinction more likely in smaller and more isolated populations (McKelvey *et al.* 2000b, pp. 25-31). Lynx populations in the DPS are at the periphery of the species' range and may behave as islands in a mainland-island metapopulation construct. In such a system, larger islands with higher habitat quality and in closer proximity to the mainland would be more likely to support persistent resident populations and to sometimes act as "sources" that produce surplus animals that may disperse to other islands. Smaller islands with lower habitat quality or at greater distance from the mainland may, in contrast, act as "sinks" that depend on immigration from source populations (McKelvey *et al.* 2000b, p. 30), and which may support resident lynx only occasionally, intermittently, or temporarily.

Formal population viability analyses (PVAs) have not been published for lynx populations in the DPS and may not be possible given limited data and natural temporal variation in demographic rates (McKelvey *et al.* 2000b, pp. 22, 30). Although some demographic data are available for

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most lynx populations in the DPS, most are limited to relatively few, small study areas or relatively short durations. There remains uncertainty about whether, and if so to what extent, the demographic health of DPS populations relies on immigration from northern (Canadian) populations; and immigration rates are not known for DPS populations (McKelvey *et al.* 2000b, pp. 24-34). These factors likely preclude development of meaningful DPS-wide or unit-specific empirical population viability models (McKelvey *et al.* 2000b, p. 22).

Slough and Mowat (1996, p. 952, Table 4) calculated population growth rate (lambda, λ) = 2.03 (annual doubling) during the 4-year increase-to-peak phase for a lynx population in the core of the species' range in the southern Yukon. This period of rapid growth was followed by a rate of λ = 1.01 (stable) during the first year of a hare decline, and λ = 0.10 and λ = 0.46 (rapid decline) during the first two years of the lynx population decline when hares were scarce. (Note – the value λ = 0.01 presented in Slough and Mowat (1996, p. 952, Table 4) appears to be an error; the correct value for λ in a population in which the estimated number of individuals declined from 135 in 1992 to 13 in 1993 should be 13/135 = 0.10 [as presented above]). However, the natural range in λ that would be expected among peripheral, isolated, or semi-isolated lynx populations where hares are non-cyclic or weakly-cyclic (i.e., in DPS populations), versus those that would signal long-term population decline or instability is unknown. Despite this, and the limitations noted above, Squires (*unpubl. data in* Lynx SSA Team 2016, p. 20) calculated population growth rates in northwestern Montana of λ = 0.92 for lynx in the Seeley Lake area (i.e., declining population trend, 1999-2007) and λ = 1.16 for lynx in the Purcell Mountains (increasing trend, 2003-2007). Likewise, McCollough (2016 *unpubl. data*; USFWS, Vortex10, deterministic population simulation) used demographic data from Vashon *et al.* 2012 (pp. 17-21) to calculate finite growth rates during a period of high hare density (λ = 1.16; increasing trend) and during a period of low hare density (λ = 0.88; decreasing trend) for the lynx population in northern Maine (see also section 4.1.1, below). Neither the Montana nor Maine estimates incorporated rates of immigration/emigration.

Although minimum viable population sizes have not been derived for lynx populations in the DPS, the Service's Recovery Outline (USFWS 2005, p. 5) suggested landscapes of at least 1,250 km^2 (483 mi^2) with sufficient boreal/subalpine habitat, hare densities (at least 0.5 hares/ha [0.2/ac]), and snow conditions favorable for lynx ("fluffy and/or deep...for sufficient periods to favor the competitive advantage of lynx"). These are the minimum landscape size and habitat conditions thought necessary to support a minimum lynx population of at least 25 adults based on a lynx density of one lynx per 50 km^2 (USFWS 2005, p. 5). McKelvey *et al.* (2000b, p. 29) noted that extinction (extirpation) risk should decrease with increasing population size, and that extinction resulting from demographic stochasticity is very unlikely even for a population (generally; not specific to lynx) with as few as 20 reproducing females. Kramer- Schadt *et al.* (2005, entire) developed a spatially explicit population model for Eurasian lynx in Germany which they combined with demographic scenarios to evaluate the likely success of potential reintroduction efforts; they concluded that at least 10 females and 5 males would be required to establish a population with an extinction probability less than 5 percent over 50 years. Rodriguez and Delibes (2003, entire) evaluated extinction among populations of Iberian lynx; they found that extinction occurred only in small populations that occupied habitats of less than

500 km^2 and that extinction within 35 years was unlikely among populations occupying areas of at least 500 km^2 of adequate habitat quality.

In summary, lynx populations need large boreal forest landscapes with snow conditions (consistency, depth, and duration) that allow lynx to outcompete other terrestrial hare predators. These landscapes must have hare densities capable of supporting (1) multiple lynx home ranges, (2) reproduction and recruitment most years, and (3) at least some survival even during years when hare numbers are low. To persist, lynx populations must exhibit recruitment and immigration rates that exceed mortality and emigration rates on average over the long-term. Immigration may be particularly important to the persistence and stability of lynx populations at the southern periphery of the range, including those within the DPS, where hare densities are generally low and hare populations are either non-cyclic or weakly-cyclic compared to northern populations. Low hare densities reduce the likelihood that lynx recruitment will consistently equal or exceed mortality, and non-cyclic or weakly-cyclic hare populations are unlikely to allow the rapid lynx population recovery observed in northern lynx populations when hare numbers increase dramatically after cyclic population crashes. Although immigration rates for DPS populations are unknown, as is the rate and periodicity of immigration needed to provide demographic stability among them, connectivity with and immigration from lynx populations in Canada is believed to be important to the persistence of lynx populations in the DPS (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; USFWS 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789).

2.3 Historical and Current Lynx Distribution

2.3.1 Lynx Distribution and Status in Canada and Alaska

The Canada lynx is broadly distributed across northern North America from eastern Canada to Alaska (McCord and Cardoza 1982, p. 729; Poole 2003, p. 361; Vashon 2015, p. 4; University of Alaska Center for Conservation Science 2016, p. 1). It is strongly associated with the expansive, continuous boreal forests of those areas, and its range largely overlaps that of its primary prey, the snowshoe hare, also a boreal forest specialist (Bittner and Rongstad 1982, p. 146; Mowat *et al.* 2000, pp. 268-269; Aubry *et al.* 2000, p. 375). In Canada, lynx are thought to occupy about 5.5 million km^2 (over 2.1 million mi^2), which represents 95 percent of their historical range in that country (Environment Canada 2014, p. 2), and over 89 percent of the species' entire distribution. Nationally in Canada, lynx are classified as secure, widespread, and abundant; they are managed for long-term population stability, with a conservative estimate of 110,000 individuals during cyclic lows; and no acute, widespread threats to lynx have been identified (Environment Canada 2014, entire; Vashon 2015, pp. 1-6). Provincially, lynx status is considered secure in British Columbia, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Northwest Territories, and the Yukon; sensitive in Alberta and Saskatchewan; at risk/endangered in New Brunswick and Nova Scotia; and undetermined in Nunavut (Environment Canada 2014, pp. 3-4; Vashon 2015, p. 1). Lynx were extirpated from Prince Edward Island (0.1 percent of lynx range in Canada) by the late 1800s, and on the mainland the

southern margin of assumed lynx range has contracted northward in Quebec, southeastern Ontario, Manitoba, Saskatchewan, and Alberta (Poole 2003, p. 361; Bayne *et al.* 2008, pp. 1192-1195; Koen *et al.* 2014a, pp. 757-760).

In Alaska, lynx are distributed across roughly 534,454 km^2 (206,354 mi^2) of boreal forest habitats (University of Alaska Center for Conservation Science, 2016, entire; Reimer 2016, *pers. comm.*), which represents about 8.7 percent of the species' distribution. Lynx in Alaska are apparently secure, with low to moderate threats, and populations appear stable statewide, although total abundance is unknown (Alaska Natural Heritage Program 2008, pp. 2-4). In both Alaska and Canada, lynx trapping is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Alaska Natural Heritage Program 2008, pp. 2-6; Vashon 2015, pp. 5-6). Along the Canada-U.S. border in provinces adjacent to DPS lynx populations, lynx trapping is prohibited in New Brunswick (adjacent to northeastern Maine) but regulated trapping is permitted in Quebec (adjacent to northwestern Maine, northern New Hampshire, and northern Vermont), Ontario (adjacent to northeastern Minnesota), Alberta (adjacent to northwestern Montana), and British Columbia (adjacent to northwestern Montana, northern Idaho, and northern Washington).

2.3.2 Lynx Distribution in the Contiguous United States

2.3.2.1 Defining Lynx Distribution at the Periphery of the Range

Several aspects of lynx population dynamics and dispersal patterns have resulted in inconsistent approaches and difficulty in defining the range and/or distribution of the species, especially at the margins (74 FR 66942). These, combined with uncertainty and ambiguity in the historical record of lynx occurrence, with early assessments based largely on trapping harvest records of questionable accuracy, particularly where lynx and bobcats overlap, and a reliance on anecdotal or unverified occurrence information (McKelvey *et al.* 2000a, pp. 208-210; 65 FR 16054), confound efforts to accurately portray the species' historical distribution in the contiguous U.S. and to assess the current distribution relative to historical conditions (79 FR 54814-54815; McKelvey *in* Lynx SSA Team 2016, p.11). They also have resulted in inaccurate portrayals of lynx distribution and misperceptions that the historical range of lynx in the contiguous U.S. was once much more extensive than is ecologically possible (68 FR 40080; 74 FR 66942).

The range of the lynx must be considered differently from those of other species that are less mobile and have more stable population dynamics. Because the lynx is highly mobile and has cyclic population dynamics that are tied to cyclic snowshoe hare populations, numbers of lynx naturally fluctuate and become extremely low at times during a cycle. Additionally, where snowshoe hare populations are not adequate, resident lynx populations cannot be sustained. Resident lynx populations never occurred everywhere boreal forest existed in the contiguous U.S. Where the boreal forest was naturally more patchy and marginal, the habitat was incapable of supporting a snowshoe hare population adequate to support a resident lynx population over

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time. Only a relatively few areas in the contiguous U.S. historically supported an adequate quantity and quality of habitat to support resident lynx populations continuously over time, and many historical lynx occurrences across a large area of the contiguous U.S. were likely dispersers. The occurrence of dispersing lynx is unpredictable, and dispersing lynx will likely continue to periodically move into areas that are not lynx habitat (68 FR 40077).

The dramatic, cyclic fluctuations in lynx populations across much of the range as they track cyclic hare populations and the mass synchronous dispersals (irruptions) of large numbers of lynx into the contiguous U.S. when northern hare populations crashed are well-documented (Elton and Nicholson 1942, entire; Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, pp. 219, 232-242; Mowat *et al.* 2000, pp. 281-294; ILBT 2013, p. 33). These events have resulted in records of lynx occurrence, in some cases very rarely, in others sometimes in large numbers and with intermittent (cyclic) regularity, in places that otherwise lack evidence of persistent lynx presence or the habitats and hare densities necessary to support a resident lynx population (USFWS 2005, pp. 3-4; 79 FR 54787-54789, 54793-54795, 54812-54823). Many records of lynx in the contiguous U.S. appear to be related to such events, including the unprecedented ‘‘explosions’’ of lynx observed in the early 1960s and 1970s (Gunderson 1978, entire; McKelvey *et al.* 2000a, pp. 232-242). During these events, many lynx occurred in anomalous habitats, exhibited unusual behavior, suffered high mortality, and numbers declined dramatically within a few years of irruptive peaks (Gunderson 1978, entire; Thiel 1987, entire; McKelvey *et al.* 2000a, p. 242). Because dispersing lynx typically do not persist in these areas of temporary range expansion, disappearing fairly quickly after irruptions, van Zyll de Jong (1971, p. 16) suggested that only areas that support lynx populations throughout both the low and the high phases of the “10-year cycle” (i.e., across the natural range of hare densities) should be considered to constitute the species’ range. In its 2003 remanded determination, the Service determined that lynx in the contiguous U.S. exist either as resident populations or as dispersers, that dispersing lynx are often found repeatedly and for variable amounts of time in habitats that cannot sustain breeding populations over time (though some breeding may occur occasionally in some of these areas), and that such areas probably contribute little to the persistence of lynx in the DPS (68 FR 40077, 40079-80). This repeated dispersal into habitats that ultimately cannot support the species (‘‘sink’’ habitats) often leads to confusion among scientists and the public about where lynx populations may be viable (74 FR 66938).

In addition to distinguishing between historical occurrence records associated with irruptions/ dispersal and those suggesting resident lynx populations, the “mainland-island” metapopulation structure thought to govern lynx populations in the DPS (McKelvey *et al.* 2000b, pp. 25-31; see Section 2.2, above) and the transitional (and, therefore, increasingly fragmented and isolated) and spatially- and temporally-shifting nature of lynx habitat at the southern periphery of the range (Koehler and Aubry 1994, pp. 78-79; McKelvey *et al.* 2000b, pp. 29-30; 74 FR 66940; 79 FR 54814) also present challenges in defining the distribution of lynx. Both factors suggest that some areas of the contiguous U.S. may naturally support resident lynx only temporarily or occasionally when habitat conditions (both boreal forest vegetation supporting abundant hares and snow conditions favoring lynx) are adequate and/or when immigration is sufficient to offset the lower productivity and recruitment rates expected among lynx populations in marginal or

suboptimal habitats. McKelvey *et al.* (2000b, pp. 21, 29-31) described such habitats as "... source-sink mosaics that shift with disturbance and succession," and the contribution, if any, of these places (especially those that act more often as "sinks" than "sources") to the maintenance and persistence of lynx populations in the DPS remains questionable (74 FR 66938).

Finally, the southern periphery of the lynx's range, where lynx are rare in many places, overlaps with the northern distribution of the much more common bobcat; the two species are difficult to distinguish in the field, they often were not reliably differentiated in historical trapping records (McKelvey *et al.* 2000a, pp. 208-209), and errors in early accounts of lynx distribution based on anecdotal information seem likely (Halfpenny and Miller 1980, pp. 1, 3-8; Meaney 2002, pp. 3-5, Hoving *et al.* 2003, pp. 366-367). Because of the large effect that relatively few errors in identification can have on assessments of the distribution of rare animals, especially those that are easily confused with a similar and more common species, McKelvey *et al.* (2000a, p. 209; 2008, pp. 553-554) suggest that anecdotal information should be interpreted with caution, and only verified occurrence data should be used to assess historical and current lynx distributions.

These complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with a naturally dynamic and transitional habitat, make it difficult, if not impossible, to precisely delineate the historical or current distribution of resident lynx populations in the contiguous U.S. (Koehler and Aubry 1994, p. 79; 68 FR 40084). While recognizing these limitations, we use our best professional judgment of the best scientific and commercial data available to make conclusions about the range of the lynx for the purposes of this SSA. In the following section, we describe the types and distributions of potential lynx habitats in the contiguous U.S., and our current understanding of the historical and current distributions of resident lynx populations in the DPS considering the factors discussed above.

2.3.2.2 Lynx Distribution within the DPS Range

The southern periphery of boreal forest vegetation extends into parts of the northern contiguous U.S., where it transitions to the Acadian forest in the Northeast (Seymour and Hunter 1992, pp. 1, 3), deciduous temperate forest in the Great Lakes regions, and subalpine forest in the Rocky Mountains and Cascade Mountains in the west (Agee 2000, pp. 40-41). In much of the DPS range, these boreal forest landscapes become naturally patchy and transitional because they are at the southern edge of the boreal forest range, and they are limited, particularly in the west, by elevation and/or aspect (Ruediger *et al.* 2000, p. 4-16; 68 FR 40090). There also is increased prevalence of non-forested land uses (e.g., agriculture, development) at the southern periphery of boreal forests. These factors generally limit snowshoe hare populations in the contiguous U.S. from achieving landscape densities similar to those of the expansive northern boreal forest in Alaska and Canada, where hares are generally more abundant and more evenly distributed across the landscape (Wolff 1980, pp. 123-128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373-375, 382, 394). Consequently, important foraging habitat for lynx is often more limited and fragmented in the contiguous U.S. than in boreal forests of northern Canada and Alaska (Berg and Inman 2010, p. 6), and overall habitat quality is typically lower.

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The habitats that lynx use in the contiguous U.S. are characterized by patchily-distributed moist forest types with relatively higher hare densities in a matrix of other habitats (e.g., hardwoods, dry forest, non-forest) with lower landscape hare densities (ILBT 2013, p.126; 78 FR 59434). In these areas, lynx incorporate the matrix habitat (non-boreal forest habitat elements) into their home ranges and use it for traveling between patches of boreal forest that support higher hare densities where most lynx foraging occurs. In some areas, patches of habitat containing snowshoe hares become so small and fragmented that the landscape cannot support lynx home ranges (ILBT 2013, p. 77) or populations over time (68 FR 40077). Additionally, the presence of more snowshoe hare predators and competitors at southern latitudes may inhibit the potential for high-density hare populations (Wolff 1980, p. 128). As a result, lynx generally occur at relatively low densities in the contiguous U.S. compared to the high lynx densities that occur in the boreal forest of Canada when hares are abundant (Aubry *et al.* 2000, pp. 375, 393-394) or the densities of species such as the bobcat, which is a habitat and prey generalist.

Snow conditions also determine the distribution of lynx (Ruggiero *et al.* 2000b, pp. 445-449), which are morphologically and physiologically adapted for hunting snowshoe hares and surviving in areas that have cold winters with deep, fluffy snow for extended periods. These adaptations provide lynx a competitive advantage over potential competitors, such as bobcats or coyotes (McCord and Cardoza 1982, p. 748; Buskirk *et al.* 2000a, pp. 86-95; Ruediger *et al.* 2000, pp. 1-11; Ruggiero *et al.* 2000b, pp. 445, 450), which have a higher foot load (more weight per surface area of foot), causing them to sink into the snow more than lynx. Therefore, bobcats and coyotes cannot hunt efficiently in fluffy or deep snow and are at a competitive disadvantage to lynx. Long-term snow conditions presumably limit the winter distribution of potential lynx competitors such as bobcats (McCord and Cardoza 1982, p. 748) or coyotes. These adaptations may also help lynx avoid predators such as mountain lions (Squires and Laurion 2000, p. 346), which also have higher foot-loading (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, p. 123), making them less efficient in deep and fluffy snow conditions.

Based on verified historical data, lynx occurrence has been documented in 24 states in the contiguous U.S. (McKelvey *et al.* 2000a, 207-232) and, more recently, in a 25th after some of the lynx released into southwestern Colorado dispersed into northern New Mexico (Colorado Division of Wildlife 2000, p. 3; 74 FR 66938), which had previously lacked verified evidence of lynx occurrence (USFS 2009, entire; 74 FR 66940-66943). Of these, and based on our current understanding of lynx and hare habitat requirements, the Service concludes that records in at least 11 states (Connecticut, Illinois, Indiana, Iowa, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Pennsylvania, and South Dakota) most likely represent occasional dispersing lynx that arrived in places with no historical or recent evidence of the habitat quality or quantity necessary to support a persistent resident lynx population (68 FR 40099; 74 FR 66940-66942; 79 FR 54807, 54817). These states are not within the distribution of resident lynx in the DPS, and we conclude that they naturally lack the necessary habitat, hare densities, and snow conditions and that they were not capable historically and are not capable now of supporting resident lynx populations.

The Service originally identified the DPS as occurring in forested portions of the remaining 14 states (Colorado, Idaho, Maine, Michigan, Minnesota, Montana, New Hampshire, New York, Oregon, Utah, Vermont, Washington, Wisconsin, and Wyoming; 65 FR 16052, 16085). Some of these states, and parts of others, are thought to have historically supported only dispersing lynx or to have only occasionally supported resident breeding lynx (68 FR 40099; 74 FR 66940). Such areas were included within the range of the DPS because of the possibility that lynx could establish small, local populations in them and perhaps contribute to the persistence of the DPS, though evidence of this was lacking (68 FR 40080; 74 FR 66938). In its 2003 remanded determination for the lynx DPS, the Service concluded that (1) potential lynx and hare habitats in Michigan, Oregon, Utah, Vermont, and Wisconsin were relatively small, isolated, and of marginal quality, and that available information suggested that these states did not historically or recently support resident lynx populations; (2) it was uncertain whether Colorado, New York, and Wyoming historically supported resident populations or only occasional dispersers; (3) New Hampshire probably supported a small resident populations that had been extirpated; and (4) the remaining states (Idaho, Maine, Minnesota, Montana, and Washington) had the best historical and recent evidence of resident breeding populations (68 FR 40082, 40086-40095, 40097-40101). Below we provide our current understanding of these state groupings and the information available since the 2003 remand that informs this understanding.

Michigan, Oregon, Utah, Vermont, and Wisconsin - Additional information and analysis available since 2003 support the determination that Michigan (Linden 2006, pp. 83-90) and Oregon (Aubry 2006, pp. 1-2) did not historically or recently support resident lynx populations, and no evidence has emerged suggesting that resident populations occurred historically or recently in Utah or Wisconsin (ILBT 2013, pp. 45, 58). The best available information continues to suggest that resident lynx did not historically and do not currently occur in Michigan, Oregon, Utah, and Wisconsin; that habitats in these states are naturally incapable of supporting resident breeding populations; and that historical and potential future occurrences of lynx in these states most likely represent occasional dispersing lynx. We conclude, therefore, that these states did not historically, do not currently, and in the future are very unlikely to, contribute to the persistence and conservation of lynx in the contiguous U.S.

In contrast, nine lynx occurrences were confirmed in the 530-km^2 (205-mi^2) Nulhegan Basin of northeastern Vermont from 2003 to 2014, and breeding was confirmed in 2012; intensified surveys since then have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*). This new information indicates that this small area of northernmost Vermont is at least occasionally capable of supporting a small number of resident breeding lynx, but that its ability to support a persistent resident population over time remains doubtful. Based on assessments of the amount and quality of potential lynx and hare habitat, snow conditions, and the presence and distribution of lynx competitors and predators (Hoving *et al.* 2005, pp. 746-749; Bernier 2015, entire), we conclude it is unlikely that northern Vermont can support a persistent resident lynx population (79 FR 54820-54821); that it only occasionally supports lynx reproduction when hare abundance and snow conditions are temporarily adequate; that it most likely represents a “sink” rather than a “source” for the regional lynx population, and that this likely represents its natural historical condition.

Colorado, New York, and Wyoming - When the Service listed the DPS in 2000, it believed that a resident lynx population occurred historically in the Southern Rocky Mountains of western Colorado and southeastern Wyoming, that lynx were also historically resident in northwestern Wyoming (part of the Northern Rocky Mountains), and that the Adirondack Mountains of northern New York may historically have supported a resident population that was by then extirpated (65 FR 16055-16056; 16058-16059). In the 2003 remand, the Service noted inconsistencies and likely errors in historical lynx reports for the Southern Rockies, questioned its original conclusion that Colorado historically supported an isolated resident population, and concluded that it was uncertain whether a resident population occurred historically in Colorado or if historical records were of periodic dispersing lynx during "extremely high populations cycles" and that a resident population never existed in southeastern Wyoming (68 FR 40081, 40091). The Service also noted that in 1999 and 2000 the Colorado Division of Wildlife (now Colorado Parks and Wildlife [CPW]) introduced 96 lynx from Canada and Alaska into southwestern Colorado (with plans to release an additional 186 lynx from 2003-2009) in an effort to reestablish a resident lynx population, that reproduction among some of the released lynx had been documented by 2003, but that it was too early to determine whether the program would be successful (68 FR 40091). In that rule, the Service also concluded that, despite evidence of reproduction in northwestern Wyoming (part of the GYA), potential habitat there is naturally marginal (patchier and composed of drier forest types), may be incapable of supporting a resident lynx population, and that lynx in northern Wyoming are most likely dispersers (68 FR 40090). Also in 2003, the Service concluded that it was possible resident lynx occurred in northern New York prior to 1900 but the potential habitat there is small, marginal, isolated and likely has only supported dispersing lynx since then (68 FR 440086-40087). In 1988-1990, 83 lynx were released into the Adirondacks of northern NY (Brocke et al. 1993, p. 1); however, that effort failed to establish a resident breeding population (65 FR 16055), suggesting that potential habitat there may be inadequate to support lynx persistence (68 FR 44486-44487).

In Colorado, after the initial release of 96 lynx in 1999 and 2000, none were released in 2001 or 2002 while protocols were evaluated and refined based on monitoring of the initially-released lynx (Shenk 2010, pp. 1, 4; Ivan *in* Lynx SSA Team 2016, p. 22). From 2003-2006, another 122 lynx were released, bringing the total to 218 (Devineau *et al.* 2010, p. 526). Reproduction was documented in 2003-2006 and 2009-2010, with 48 dens documented in that time, including a third generation of Colorado-born lynx (Shenk 2010, p. 5; Ivan *in* Lynx SSA Team 2016, p. 22). In 2010, CPW determined that all benchmarks for its lynx program had been met and had resulted in the establishment of a viable, self-sustaining lynx population (Ivan 2011b, pp. 11, 12). Intensive monitoring of the population ceased in 2010 and was replaced by an effort to develop a minimally-invasive long-term monitoring program (Ivan 2011b, entire), which used snow-tracking surveys and camera traps to document continued lynx presence in the core release area of the San Juan Mountains in 2010-11 and again in 2014-15, with evidence of reproduction also documented during that time (Ivan *et al.* 2015, p.1; Ivan *in* Lynx SSA Team 2016, pp. 22-23). In its 2014 revised critical habitat designation for the DPS, the Service concluded that the historical record of verified lynx occurrence in Colorado combined with naturally highly-fragmented and isolated potential habitat and generally low snowshoe hare

densities suggest that Colorado and the Southern Rockies were unlikely to have historically supported a persistent resident lynx population and that the long-term persistence of the introduced population is uncertain (79 FR 54787-54789, 54793-54795, 54816-54817). The current size of the resident lynx population in Colorado is unknown but thought to number between 100 and 250 (Ivan *in* Lynx SSA Team 2016, p. 47). We continue to believe that available information suggests Colorado did not historically support a persistent resident lynx population and that the long-term persistence of the introduced population remains uncertain.

Information and analyses since the 2003 remand support the conclusion that New York has inadequate habitat quantity and quality (both vegetation and snow conditions) to support a resident lynx population (Hoving *et al.* 2005, pp. 746, 749). Based on Hoving *et al.* (2005) and our evaluation of the verified records of historical occurrence presented by McKelvey *et al.* (2000a, pp. 215-217), we conclude that the Adirondack Mountains of northern New York have not recently and likely did not historically support a persistent resident lynx population, are likely incapable of doing so, that verified historical records were most likely of dispersing lynx, and dispersing lynx may currently and in the future continue to occur rarely and temporarily in northern New York.

In northwestern Wyoming, additional information available since 2003 documented continued presence of a small number of lynx as recently as 2010, including some evidence of reproduction during that time, and documentation of Colorado-released lynx that dispersed into and through Wyoming (Squires *et al.* 2003, entire; Squires and Oakleaf 2005, entire; Murphy *et al.* 2006, entire; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016, *pers. comm.*; Hanvey 2016, *pers. comm.*; Ivan 2016a, *pers. comm.*; Murphy 2016, *pers. comm.*). However, more recent surveys and research-related trapping efforts have failed to detect lynx in this area or elsewhere in Wyoming since 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45). In the 2014 revised critical habitat designation, the Service noted:

> Although the GYA has a long history of lynx presence and recent evidence of reproduction (Squires and Laurion 2000, entire; Squires *et al.* 2001, entire; Murphy *et al.* 2006, entire), there are relatively few verified records of lynx from Yellowstone National Park and surrounding areas (65 FR 16058, 68 FR 40090). Additionally, lynx habitat in the GYA is naturally marginal (patchier and composed in many places of drier forest types), less capable of supporting snowshoe hares (Hodges *et al.* 2009, entire), and farther from source populations than most other parts of the DPS range (68 FR 40090). Given the naturally marginal habitat in this largely protected area, we believe it is unlikely that the GYA ever supported more than a handful of lynx home ranges in any given year. We find no evidence that the GYA once supported a larger or more robust lynx population than the small one suggested by verified historical and recent records and survey efforts (79 FR 54791).

We concluded that the historical record and recent evidence of lynx occupancy and reproduction suggested the presence of a small but persistent resident lynx population in the GYA of northwestern Wyoming and southwestern Montana (79 FR 54791, 54796-54797,

54825-54826); however, the consistency of occupancy over time remains uncertain (Lynx SSA Team 2016, pp. 11, 45, 57). Uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016, p. 57). If residency was intermittent historically, the current apparent absence of resident lynx might be a natural condition related to the area's largely marginal or suboptimal habitat conditions - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. In that case, future intermittent residency would be expected, but only if lynx dispersing from a source population immigrate to the GYA when habitat conditions and hare densities return to more favorable levels. Conversely, if the GYA always historically supported a small number of resident lynx but no longer does, it may suggest that some factor or factors have acted to tip the quality of the area's habitat from just barely capable of supporting a small resident population to no longer capable of doing so, resulting in extirpation. We conclude that this uncertainty cannot be resolved based on the available information but, given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its historical inability to support a robust, persistent resident population and its apparent recent inability to support any resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. We also note that extensive areas of the GYA were burned by the large, intense wildfires of 1988, and that these areas may soon (perhaps in the next 5-15 years) regenerate to a stage containing the dense horizontal conifer structure favorable for hares and, therefore, lynx foraging habitat, perhaps increasing the likelihood that the GYA may support resident lynx again in the near future (Lynx SSA Team 2016, p. 46).

In southern Wyoming, all recent occurrences of lynx appear to be of Colorado-released lynx that moved into or through the area (see Devineau *et al.* 2010, Fig. 1, p. 526), including one female who in 2004 established a den in the Snowy Mountains and produced kittens that did not survive (Bjornlie 2016, pers, comm.; Ivan 2016a, *pers. comm.*). Based on the available information, we conclude that southern Wyoming did not historically or recently support a resident lynx population and is not now capable of doing so.

New Hampshire - There were 18 confirmed lynx records indicating 28 individual lynx in northern New Hampshire from 2006 to 2013, with evidence of reproduction in 2010 and 2011 (79 FR 54820). An additional 8 lynx detections were documented in 2014 (Siren 2014, p. 7), 24 lynx track intercepts were recorded during snow-tracking surveys during the winter of 2014-2015 (Siren 2016, p. 1), and surveys in 2016 also detected lynx (Siren 2016, *pers. comm.*). Most records since 2006 are in the vicinity of Pittsburg in the northernmost reaches of the state, though lynx detections in 2015 and 2016 suggest a southern expansion from the area of 2006-2014 detections (Siren 2016, p. 1; Siren 2016, *pers. comm.*). Despite recent evidence of lynx residency and reproduction, the Service concluded in the 2014 revised critical habitat designation that, based on modeling of the amount of potentially suitable habitat and favorable snow conditions (Hoving *et al.* 2005, pp. 739, 749; Litvaitis and Tash 2005, p. A-298), it is

unlikely that northern New Hampshire will support a resident breeding population over the long-term (79 FR 54820-54821). Siren (2014, p. 10) suspected that the relatively few lynx detections documented in 2012-2014 may be related to the presence and abundance of bobcat, coyote, and fisher populations in much of northern New Hampshire. We conclude that northern and central New Hampshire likely supported a small resident lynx population historically that was extirpated during the latter half of the 20th century. We are uncertain whether lynx detections in northernmost New Hampshire over the past decade may represent the natural reestablishment of a small resident breeding population in the state or if it is a temporary phenomenon related to an expanding source population in neighboring northern Maine (79 FR 54821). Although bobcat populations have increased and expanded their range in this region in recent decades (Lavoie *et al.* 2009, pp. 873-874), severe winters and deep snow can substantially limit their populations (Reed 2009, pp. 29-33; McCord, 1974, pp. 433-434). Maine's bobcat harvest declined substantially after two deep snow winters in 2008 and 2009 (Maine Department of Inland Fisheries and Wildlife 2015, p. 37). It is possible that these anomalous deep snow winters provided a temporary competitive advantage to lynx in northern New Hampshire.

Idaho, Maine, Minnesota, Montana, and Washington - These states (along with New Hampshire, above) have the strongest historical evidence of continuous lynx presence and recent evidence of resident lynx populations (McKelvey *et al.* 2000a, pp. 211-228; 68 FR 40086-40095, 40097-40101; McKelvey *in* Lynx SSA Team 2016, p. 11). Historical lynx records exist for much of Idaho, but many, especially in the central and southern part of the state, occurred in anomalous habitats or were associated with large irruptions of lynx from Canada to the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 225-227). The historical record and recent surveys (summarized at 79 FR 54818-54820; also see U.S. District Court ID 2016, pp. 18-24) suggest that only dispersing lynx occur throughout most of Idaho, habitats in many parts of the state are drier forest types that support lower densities of hares, and resident lynx seem to be confined to the Purcell, Selkirk, and possibly the Cabinet mountain ranges in the northern panhandle. The number of resident lynx in northern Idaho is unknown but certainly small based on the amount of potential habitat, and resident lynx here are part of a larger population that occurs primarily in northwestern Montana and southeastern British Columbia.

Maine has a long history of continual lynx presence, with evidence of a persistent resident population in much of the northern half of the state (McKelvey *et al.* 2000a, pp. 211-212; Hoving *et al.* 2003, entire;), which currently is believed to support the largest lynx population in the DPS (Vashon *et al.* 2012, pp. 50-60; 79 FR 54784-54785, 54792, 54822-54824; Vashon *in* Lynx SSA Team 2016, p. 18). The current amount and distribution of high-quality lynx and hare habitat and the number of resident lynx in Maine are all much larger than was suspected at the time of listing or the 2003 remand, and all are probably substantially larger now than under likely typical historical conditions. Although the current population size in Maine is uncertain, habitat distribution and lynx home range data suggest this geographic unit could potentially support 750-1,000+ resident lynx (Vashon *in* Lynx SSA Team 2016, p. 18]). The current lynx population in Maine is supported by the broad distribution of high-quality hare habitat that resulted from extensive, large-scale clearcutting in the 1970s and 1980s in response to a massive spruce

budworm (*Choristoneura fumiferana*) outbreak (68 FR 40087; 79 FR 54792; also see section 4.1.1, below). As these regenerating clearcuts, which currently provide the dense horizontal structure preferred by hares, mature beyond about 35 years post-harvest, hare densities decline as cover and forage are reduced as a result of forest succession (Simons 2009, p. 217; Simons-Legaard *in* Lynx SSA Team 2016, p. 16). The current lynx population in Maine is probably larger than the likely historical condition, when relatively small amounts of the spruce-fir forests in the state are thought to have been composed of young stands (Lorimer 1977, entire; 68 FR 40094; Vashon *et al.* 2012, pp. 45, 56; 79 FR 54792). With the reduction in clearcutting and the proliferation of partial harvesting following enactment of the Maine Forest Practices Act of 1989, it is projected that lynx densities in Maine will decline by 55 to 65 percent by 2032 (Simons 2009, p. 217; Simons-Legaard *in* Lynx SSA Team 2016, p. 16). Lynx in Maine likely represent the southern periphery of a larger population that occurs in northern New Brunswick and southern Quebec south of the St. Lawrence Seaway/River, which appears to partially isolate lynx in this region, demographically and genetically, from populations in the core of the species' range (Koen *et al.* 2015, entire). The extent to which lynx persistence in Maine relies on immigration from Canada is unknown.

In Minnesota, research conducted since the 2003 remand has demonstrated the continuous presence of a resident lynx population in the northeastern part of the state that seems to be the southern periphery of a larger population in southwestern Ontario (Moen *in* Lynx SSA Team 2016, pp. 19, 39). The number of resident lynx in Minnesota is unknown but believed to be between 50 and 200 (Moen *in* Lynx SSA Team 2016, pp. 19, 39). Lynx are occasionally detected in other parts of the state, but hare densities and snow conditions consistently favorable for lynx appear to be restricted to the northeastern "Arrowhead" region of the state, and areas to the south and west are dominated by bobcats. Although there are currently more lynx in Minnesota than suspected at the time of listing, it is unclear whether current numbers and distribution are similar to the historical condition. The extent to which lynx persistence in Minnesota relies on immigration from Canada is also unknown.

In Montana, research conducted since the DPS was proposed for listing has documented the continued presence and broad distribution of resident lynx in much of the northwestern portion of the state (Squires *in* Lynx SSA Team 2016, p. 20). The number of resident lynx in northwest Montana is unknown but believed to be between 200 and 300 (Squires *in* Lynx SSA Team 2016, p. 41) in three subpopulations - the Purcell Mountains, Seeley Lake/Central, and Garnet Mountains subpopulations (Squires *in* Lynx SSA Team 2016, p. 20). Recent (2014-2015) surveys failed to detect lynx in the Garnet Mountains in the southern part of the area (Squires *in* Lynx SSA Team 2016, p. 20), which had residents as recently as 2010 and is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016, *pers. comm.*). Lynx in northwestern Montana (and northern Idaho) likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia. The extent to which lynx persistence in this area relies on immigration from Canada is unknown, and there is no indication of substantial immigration from Canada after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). In southwest Montana, few lynx and no recent evidence of reproduction have been documented in the Montana portion of the GYA where, as with the northwestern Wyoming part

of the GYA (discussed above), uncertainty about whether this area consistently or only intermittently supported resident lynx historically makes it difficult to interpret their recent apparent absence from the area (Lynx SSA Team 2016, p. 57). As elsewhere in the West, recent research and habitat assessments suggest that habitats capable of supporting resident lynx in Montana are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12).

In Washington, research and monitoring conducted since the 2003 remand has continued to document a resident lynx population in the Okanogan region of the eastern Cascade Mountains in the north-central part of the state (von Kienast 2003, entire; Maletzke 2004, entire; Koehler *et al.* 2008, entire; Maletzke *et al.* 2008, entire; Maletzke *in* Lynx SSA 2016, pp. 21-22). Since at least 1985, this is the only area of the state with evidence of a resident breeding population (Koehler and Maletzke 2006, p. 4; Koehler *et al.* 2008, p. 1518; ILBT 2013, p. 58; Maletzke *in* Lynx SSA 2016, p. 21), although the Kettle Mountains in the northeastern part of the state are thought to have historically supported a small breeding population, and lynx are detected there occasionally (Stinson 2001, pp. 13–14; Koehler *et al.* 2008, p. 1523; USFWS 2008a, p. 2). Multiple large fires in the Okanogan over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). Although these areas should regenerate into lynx and hare habitat, it may take 35-40 years (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and insect impacts could further diminish habitat availability and the lynx population's probability of persistence (Lynx SSA Team 2016, p. 44; see also sections 3.4, 4.1.4, and 5.1.4, below).

In summary, although uncertainty remains regarding the historical distribution of resident lynx in the DPS and small breeding populations may have been lost from some places, neither broad-scale breeding range contraction nor substantial population declines in the contiguous U.S. from historical conditions until the DPS was listed have been documented based on verified occurrence data (68 FR 40099; 72 FR 1187; 79 FR 54798, 54815; McKelvey *in* Lynx SSA Team 2016, p. 11). New information summarized above indicates that there are many more lynx in Maine and Minnesota than was suspected at the time of listing, and there are naturally fewer lynx and a more limited distribution of suitable habitats in the western U.S. than was previously thought (68 FR 40085, 40091-40092; ILBT 2013, p. 23). Lynx in Maine are at historically high numbers and may currently be facilitating the recolonization of formerly occupied habitat in northern New Hampshire and recent lynx occurrences in northernmost Vermont. However, lynx persistence is uncertain in New Hampshire and unlikely in Vermont, and lynx numbers in Maine are projected to decline over the next several decades. In the West, small breeding populations in the GYA and the Garnet Mountains of Montana may recently have become extirpated (although both also may be only temporarily "winked off" in a metapopulation dynamics sense). In north-central Washington, lynx habitat and numbers have declined because of recent large fires and insect outbreaks, and the persistence of the breeding population there could be threatened if additional such impacts occur with similar magnitude and frequency over the next

several decades. As a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, resident lynx currently occur in western Colorado. Although the number of lynx in this population and its future persistence are uncertain, Colorado currently supports more lynx than it likely did, based on the historical record, for much of the previous century. The geographic units evaluated in this SSA include all areas in the contiguous U.S. with strong historical and recent evidence of persistent resident lynx populations. Detailed assessments of the current status and future viability of resident lynx populations and habitats in these areas are presented in chapters 4 and 5 below.

Chapter 3: Factors Influencing Viability of the DPS

In this chapter we discuss factors thought to influence the historical and current distribution and status of lynx populations in the contiguous U.S., their likely influence on the future viability of the DPS, and we describe the cause-and-effects pathways of impacts associated with particular factors. We focus on the factor for which the DPS was listed under the ESA (the inadequacy of regulatory mechanisms in Federal land management plans at the time of listing) and on the anthropogenic influences identified by the ILBT in the revised LCAS as having the potential to exert population-level impacts on lynx and lynx habitats (ILBT 2013, pp. 68-78). Those anthropogenic influences - climate change, vegetation management, wildland fire management, and habitat loss and fragmentation - are considered the most influential factors in the future viability of the lynx DPS.

3.1 Regulatory Mechanisms

A number of activities with the potential to affect lynx habitat suitability, productivity, mortality, and movements via habitat loss or fragmentation, creation of barriers, or that otherwise alter the vegetation mosaics and prey abundances maintained historically by natural disturbance processes may occur in lynx habitats regardless of land ownership and management. The extent to which regulations guide such activities to avoid, minimize, or mitigate impacts to lynx influences the current and future likelihoods that those habitats will provide the physical and biological features needed to support resident lynx populations. As described in more detail below, the lynx DPS was listed as threatened because of the lack of specific conservation direction and associated regulations on Federal lands. At that time, the available information indicated that most lynx habitat in the DPS occurred on Federal lands, predominantly in the western U.S. (65 FR 16061). Since then, research and monitoring have revealed that non-Federal lands contribute more to the conservation of the DPS than was known at the time of listing, particularly in the Northern Maine and Northeastern Minnesota regions. Therefore, in the following sections we describe and compare the Federal regulatory environment for lynx in the DPS at the time of listing and currently, and we describe other regulatory mechanisms as they pertain to lynx on private as well as State and Tribal lands.

Since it was listed in 2000, the DPS has been protected by the ESA's prohibition on take (under section 9), which applies to lynx wherever they occur in the DPS, regardless of land ownership.

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The DPS has also been protected since listing by section 7 of the ESA, which requires Federal agencies to use their authorities to conserve listed species and to consult with the Service for any actions they implement, fund, or permit (i.e., for which a "Federal nexus" exists) and which may affect lynx or lynx habitats within the DPS, again regardless of land ownership. Additionally, section 4 of the ESA requires that critical habitat, defined as the specific geographic areas containing the physical and biological features essential for the conservation of a listed species and that may require special management and protection, be designated for listed species, and section 7 prohibits the destruction or adverse modification of such designated habitats. Critical habitat was designated for the lynx DPS in 2007 and was revised in 2009 and 2014. Section 4 also requires recovery planning for listed species; a recovery plan for the lynx DPS has not yet been completed, but part of the purpose of this SSA is to inform near-term recovery planning direction.

3.1.1 Federal Regulatory Mechanisms

Federal lands make up approximately 64 percent of the lands encompassed by the six geographic units evaluated in this SSA. Of those Federal lands, roughly 87 percent is managed by the U.S. Forest Service (USFS), 11 percent by the National Park Service (NPS), and two percent by the Bureau of Land Management (BLM). The amount of Federal land varies by unit, ranging from one percent in the Northern Maine Unit to over 97 percent in the GYA Unit (see Table 2, above, and Chapter 4, below, for ownership in each geographic unit). Federal lands management is guided by a number of statutes and associated regulations, policies, standards, guidelines, and best management practices applied by managing agencies to meet legislative mandates and achieve agency missions (for a summary of relevant Acts and associated regulations and guidance, see USFWS 2014, pp. 24-34). Many of these regulatory mechanisms provide some benefits to lynx and protect lynx habitats (USFWS 2014, pp. 24-34). For example, the conservation priority in the management of NPS lands in accordance with the National Park Service Organic Act (16 USC 1 et seq. as amended), the National Parks and Recreation Act (Public Law 95-625), and the Wilderness Act (16 USC 1131-1136, 78 Stat. 890) likely provides an adequate regulatory framework for the conservation of lynx populations and habitats in the NPS units in which they occur (USFWS 2014, pp. 28-29, 31-33). However, it was the absence of specific management direction and conservation measures for lynx and lynx habitats in USFS and BLM land management plans that led the Service to conclude that the regulatory mechanisms in those plans at the time of listing were inadequate to provide for the conservation of the DPS. Therefore, the evaluation below focuses on the efforts of USFS and BLM, in collaboration with the Service, to address the regulatory inadequacy for which the DPS was listed.

The Service designated lynx in the contiguous U.S. as a DPS and listed it as threatened under the ESA in 2000 because of the inadequacy, at that time, of existing regulatory mechanisms. Specifically, at that time the Service believed that most lynx populations and potential lynx habitats (broad forest vegetation classes defined as "lynx forest types" [65 FR 16071]) in the contiguous U.S. occurred on Federal (USFS, NPS, and BLM) lands in the western states, and that the plans that guided management of those lands (particularly USFS and BLM lands)

included "...programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species" (65 FR 16052, 16082). At that time, the Service found that USFS and BLM management plans did not adequately address risks to lynx and, as identified in the LCAS (Ruediger *et al.* 2000, pp. 2-1 through 6-3), those plans allowed actions that cumulatively could result in significant detrimental effects to lynx in the contiguous U.S. As a result, the Service concluded in the final rule that the lack of Federal land management plan guidance for the conservation of lynx and the potential for those plans to allow or direct actions that could adversely affect lynx constituted a significant threat to the DPS (68 FR 40096).

In 1998, in anticipation of the DPS's listing under the ESA, regional and state directors of the Service, USFS, BLM, and NPS approved preparation of the interagency LCAS to provide a consistent and effective approach to conserve lynx and to assist with Section 7 consultation on Federal lands. An interagency Steering Committee selected a Science Team to assemble the best available scientific information on lynx and appointed the ILBT to prepare a lynx conservation strategy applicable to Federal land management in the contiguous U.S. (USFWS 2014, p. 15). The first edition of the LCAS was completed in January, 2000 and revised in August, 2000 (Ruediger *et al.* 2000, entire). The Steering Committee subsequently issued several amendments and clarifications, and the most recent revision of the LCAS was completed in August, 2013 (ILBT 2013, entire). The LCAS initially identified and evaluated 17 risk factors (e.g., timber and fire management, recreation, roads, livestock grazing, trapping, etc.) thought to have the potential to affect lynx habitat suitability, productivity, mortality, and movements and that may be addressed under programs, practices, and activities within the authority and jurisdiction of Federal land management agencies. These risk factors included programs or practices with the potential to result in habitat conversion, habitat fragmentation, or obstruction to lynx movement; roads or winter recreation trails that may facilitate access to historical lynx habitat by competitors; and fire suppression, which changes the vegetation mosaic maintained by natural disturbance processes. The risks identified in the 2000 LCAS were based on potential effects to lynx habitats and to individual lynx, lynx populations, or both; therefore, not all of the risks initially identified in the LCAS were thought to threaten lynx populations in the DPS (68 FR 40096). In the 2013 revised LCAS, risk factors were redefined as "Anthropogenic Influences on Lynx and Lynx Habitat," and grouped into two tiers based on the potential magnitude of effects (ILBT 2013, pp. 1, 68). First tier influences (climate change, vegetation management, wildland fire management, and habitat fragmentation - discussed in the remainder of this chapter, below) are those with potential to negatively affect lynx populations and habitats, while second tier influences are those that may affect individual lynx but are not expected to substantially impact populations or habitats (ILBT 2013, pp. 68-85).

In addition to identifying risks, the LCAS also directed Federal agencies to map potential lynx habitat and identify lynx analysis units (LAUs) to evaluate potential impacts of management actions on lynx and snowshoe hare habitats. Finally, the LCAS developed recommended conservation measures, standards, and guidelines to be applied to lynx habitats on Federal lands that were designed to mimic historical conditions and landscape-scale disturbance

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patterns and to maintain or improve lynx and hare habitats at both local (project-level) and landscape scales (USFWS 2014, p. 16). After its initial completion in 2000, USFS and BLM managers within the range of the DPS agreed to implement the standards and guidelines identified in the LCAS until management plans could be formally amended to specifically address lynx conservation. In 2000, the Service, USFS, and BLM developed and adopted Canada Lynx Conservation Agreements (CAs; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire) in which the BLM and USFS agreed to coordinate assessment and planning efforts with the Service to assure a comprehensive approach to lynx conservation and to use the LCAS, supporting science, and locally specific information as the basis for the approach and to streamline consultation under section 7 of the ESA. The USFS further committed to deferring any actions not involving third parties that would adversely affect lynx until such time as the Forest Plans were amended or revised to adequately conserve lynx (USFS and USFWS 2000, p. 8; 68 FR 40083).

Concurrent with development of the LCAS and interagency CAs, the USFS and BLM in 1999 completed the *Biological Assessment* (BA) *of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada Lynx* (USFS and BLM 1999, entire). The BA identified and evaluated the potential effects to lynx of implementation of 57 USFS Land and Resource Management Plans and 56 BLM Land Use Plans throughout the 14 states in which the lynx DPS was proposed for listing. The BA concluded that the potential for adverse effects to lynx existed on each administrative unit in each geographic area and that, cumulatively, implementation of the existing plans was likely to adversely affect the DPS. It recommended that all of the plans be amended or revised to incorporate conservation measures to reduce or eliminate adverse effects to lynx (USFS and BLM 1999, p. 14). In its 2000 biological opinion on the BA, the Service evaluated the USFS and BLM plans in conjunction with the CAs described above (USFWS 2000, p. 15). The Service concluded that implementation of the existing plans in accordance with the CAs until plans could be formally amended or revised was not likely to jeopardize the DPS, but that amendments or revisions to those plans were needed to further reduce or avoid the potential for adverse effects to lynx (USFWS 2000, pp. 48-50).

In the 2003 remanded rule, the Service similarly determined that adherence to the CAs, the biological opinion, and the LCAS in assessing the impacts of Federal actions on lynx alleviated the potentially-adverse effects of Federal land management activities on lynx, but that amendment of USFS and BLM land management plans to conserve lynx would be the strongest mechanism to ensure long-term conservation of lynx and lynx habitat on Federal lands (68 FR 40096-97). It concluded that although Federal, State, and Tribal regulations and plans had reduced threats to the DPS, the inadequacy of existing regulatory mechanisms still posed a moderate, albeit lower-level threat, and would continue to do so until Federal land management plans were specifically amended to address lynx conservation (68 FR 40097).

Since the 2003 remand, most Forest Service units with lynx forest types have formally amended or revised their land management plans to incorporate the conservation measures, standards, and guidelines identified in the LCAS. From 2004-2006, forest plans for seven national forests

with potential lynx habitat in Maine, New Hampshire, Vermont, Michigan, Minnesota, and Wisconsin were revised to include recommendations from the LCAS and the CAs (Jackson 2015, pers. comm.; USFWS 2104, p. 33). In 2007, the USFS completed the Northern Rockies Lynx Management Direction (NRLMD), which formally amended management plans to include lynx conservation measures, standards, and guidelines for 18 national forests covering over 150,000 km^2 (57,915 mi^2) in Idaho, Montana, Wyoming and Utah, including over 72,000 km^2 (27,800 mi^2) of potential lynx habitat (USFS 2007, entire; USFWS 2014, pp. 16-19; 79 FR 54813; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). In 2008, USFS similarly completed the Southern Rockies Lynx Amendment (SRLA), which formally amended forest plans covering about 59,000 km^2 (22,780 mi^2), including over 30,000 km^2 (11,583 mi^2) of mapped (potential) lynx habitat on 7 national forests or national forest complexes in western Colorado and southern Wyoming (USFS 2008, entire; Jackson 2015 *in* Lynx SSA Team 2016, Appendix 3, p. 11). The management direction adopted in the Northern and Southern Rockies amendments was developed in accordance with the National Forest Management Act of 1976 and the regulations that implement the statute (36 CFR 219.22), which requires public review and comment as part of the decision making process. Among national forests within the geographic units evaluated in this SSA, only those in Washington (the Okanogan-Wenatchee and Colville national forests) have not formally amended or revised their land and resource management plans. However, the plan revision process has been initiated for both forests, and both continue to manage for lynx habitats in accordance with the LCAS and the CA.

BLM lands account for just over 1 percent of the total area within the SSA geographic units, and most occur in Colorado, Montana, and Wyoming (Table 2, above). In the Western Colorado SSA unit, BLM Field Offices that contain potential lynx habitat include the Colorado River Valley, Grand Junction, Gunnison, Kremmling, Little Snake, Royal Gorge, San Luis Valley, Tres Rios, Uncompahgre, and White River Field Offices. These BLM areas were subject to the 2000 interagency CA; however, that CA expired in 2004 (BLM and USFWS 2000, p. 8) and was not renewed. Since then, BLM Resource Management Plans (RMPs) have been revised on the Colorado River Valley, Grand Junction, Kremmling, Little Snake, and Tres Rios Field Offices. RMPs for the Gunnison, Royal Gorge, San Luis Valley, Uncompahgre, and White River Field Offices have not been revised and do not contain specific measures for the conservation of lynx. BLM lands in the Garnet Resource Area in Montana and parts of the Kemmerer and Pinedale districts in Wyoming occur within the Northwestern Montana/Northeastern Idaho and GYA SSA geographic areas, respectively. These areas were also designated as lynx critical habitat. The RMP for the Garnet area was amended in 2004 to formally adopt the conservation measures of the LCAS (BLM 2004a, 2004b, entire), and the RMPs for the Pinedale and Kemmerer districts were revised in 2008 and 2010, respectively, to adopt conservation measures and best management practices for lynx (BLM 2008b, pp. A18-10 - A18-16; BLM 2010b, pp. A-9 - A-12).

The completion and implementation of the LCAS, the interagency CAs, and the subsequent formal management plan revisions and amendments all were undertaken to address the inadequacy of regulatory mechanisms on USFS and BLM lands for which the DPS was listed. Each incorporated the best available scientific information to develop goals, objectives, conservation measures, standards, and best management practices (BMPs) to guide USFS and

BLM management activities at both project- and landscape-level scales to reduce or eliminate the potential for adverse effects to lynx or its habitats and thus promote the conservation of the DPS (Ruediger *et al.* 2000, pp. 7-1 - 7-18; BLM and USFWS 2000, entire; USFS and USFWS 2000, entire; USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). Standards and guidelines developed and implemented in accordance with the NRLMD and the SRLA were designed to promote beneficial effects and limit potentially adverse effects of management activities (vegetation management [e.g., timber harvest, precommercial thinning], wildland fire and fuels management, grazing, recreation, road/access management, energy development, etc.) on important lynx habitats including winter snowshoe hare habitat (high-quality lynx foraging habitat), denning habitat, and linkage/connectivity corridors (USFS 2007, pp. 8-30, USFS 2008, pp. 6-19, Attachment 1-1 - 1-9). The USFS concluded that the vegetation standards adopted in the NRLMD that limit the total amount and the rate at which lynx habitat can be converted to temporarily unsuitable habitat (stand initiation seral stage following timber harvest) ensure that the agency's timber management program is beneficial to lynx and will provide sufficient lynx habitat through time at both LAU and landscape-level scales (USFS 2007, p. 35). In its biological opinion on the NRLMD, the Service concluded that its application "...would substantially reduce or eliminate adverse effects to lynx from Forest Service land management activities on at least 94 percent of this area, and more likely nearer to 98 percent" (USFWS 2000, p. 76). Similarly, in its 2008 biological opinion on the SRLA, the Service concluded that vegetation management standards in the SRLA would prohibit treatments that could adversely affect essential components of lynx habitat on 95.5 percent of the mapped (potential) lynx habitat in the SRLA area (USFWS 2008b, p. 52).

In summary, all USFS and some BLM lands with known or potential lynx habitat within the range of the DPS, including all SSA geographic units, are currently managed in accordance with the specific conservation measures and considerations identified in the LCAS and implemented via the CAs or formally revised and amended management plans described above. These agreements and revised/amended plans constitute the regulatory framework and specific regulatory mechanisms adopted to conserve lynx habitats and populations on USFS and BLM lands that support or are capable of supporting them. They represent the agencies' efforts, in collaboration with the Service, to address and ameliorate the singular threat for which the lynx DPS was listed under the ESA. Although formal effectiveness monitoring has not been completed, it's clear that implementation of the CAs and revised/amended plans, and the associated programmatic and project-specific consultations between BLM/USFS and the Service in accordance with section 7 of the ESA, have resulted in avoidance/minimization of impacts to important lynx and hare habitats on Federal lands and have reduced the likelihood that management activities on these lands may adversely affect lynx in the contiguous U.S.

3.1.2 State Regulations and Tribal Management

Private, State, and Tribal lands make up the remaining 36 percent of the lands encompassed by the six geographic units evaluated in this SSA, accounting for almost 27 percent, almost nine percent, and one percent of the total, respectively (Table 2). The amount of private land varies by unit, ranging from 0.3 percent in the North-central Washington Unit to over 90 percent in the

Northern Maine Unit. Likewise, State ownership varies from less than one percent in the GYA and Western Colorado units to 36 percent in the Northeastern Minnesota Unit. Tribal lands account for about four percent of the Northwestern Montana/Northeastern Idaho Unit and roughly one percent of the Northern Maine and Northeastern Minnesota units; there are no Tribal lands in the North-central Washington, GYA, or Western Colorado units. Private, State, and Tribal lands, combined, constitute 99 percent of the lands in the Northern Maine Geographic Unit and over half of those in the Northeastern Minnesota Unit. Because both of these units support larger resident lynx populations than was suspected when the DPS was listed and, therefore, may contribute more substantially to the conservation of the DPS than was understood at the time of listing, we must evaluate the regulatory mechanisms that pertain to lynx on these lands (Lynx SSA Team 2016, p. 54). Although private, State, and Tribal lands constitute much smaller proportions of the other four (western) geographic units (from about 3 percent to 16 percent, combined), important lynx habitats occur on some of those lands, and regulatory mechanisms may influence their contributions to the conservation and persistence of DPS populations or parts of them. Therefore, in this section, we summarize the relevant regulatory frameworks and mechanisms that may affect lynx on private, State, and Tribal lands within the six geographic units of the DPS, but with a focus on those units with the greatest proportions of these lands and on activities on these lands with the greatest potential to impact lynx.

State Wildlife Management Regulations - The following information is derived from the Service's 2014 Incremental Effects Memorandum prepared in support of the revised designation of critical habitat for the lynx DPS (USFWS 2014, pp. 35-38) and updated as warranted by new information. State furbearer and other wildlife management regulations benefit lynx populations in the states where they occur. In addition to State and private lands, State wildlife regulations govern hunting and trapping activities on many Federal lands where those activities are permitted. Most states within the range of the lynx prohibited trapping and hunting of lynx prior to the 2000 listing of the DPS under the ESA, and those activities were prohibited in all states once the DPS was listed. All states within the lynx DPS range that allow legal bobcat harvest (1) manage in accordance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Export Program for Appendix II Furbearer Species (USFWS 2014, pp. 25-26), (2) have distributed information to bobcat trappers and hunters on how to avoid incidental take of lynx, and (3) report all known incidences of incidental take of lynx to the Service's Division of Management Authority to assure that take does not exceed the amount permitted under the intra-agency section 7 consultation for the CITES Export Program (USFWS 2001, entire). Most states have also adopted special regulations in areas where lynx occur to minimize the potential for incidental take (including injury) of lynx during legal trapping of other furbearers. These efforts benefit lynx and are expected to do so in the future with continued implementation and enforcement.

Unit 1: Northern Maine - In 1967, a bounty on lynx in Maine was repealed, and lynx were given complete protection from trapping and hunting. The Maine Department of Inland Fisheries and Wildlife (MDIFW) has adopted special trapping regulations in Wildlife Management Districts where lynx may occur that address specifics about traps sizes and sets that may be used to

legally harvest other furbearers and that are intended to minimize the likelihood of incidentally trapping lynx (http://www.eregulations.com/maine/hunting/lynx-protection-zone-trap-restrictions/). MDIFW also adopted and made available for download on its web page the interagency brochure *How to Avoid Incidental Take of Lynx while Trapping or Hunting Bobcats and other Furbearers*, and modified it to be more specific to Maine. MDIFW also set-up an incidental lynx capture hotline and requires that all incidentally trapped lynx be reported (http://www.maine.gov/ifw/hunting_trapping/trapping/avoid_lynx.htm, last accessed 8.08.2016), and has staff on stand-by to help immobilize, evaluate, collect tissue and/or hair samples, and release, if appropriate, any lynx reported to the hotline. This program has resulted in the release of 98 lynx from 2000 - 2015 (ten lynx died from traps or illegal shooting in traps) that were reported incidentally trapped in northern Maine (MDIFW 2014, p. 75). After preparing a habitat conservation plan (Incidental Take Plan), the MDIFW in 2014 obtained an incidental take permit from the Service for lynx trapped incidental to predator management and animal damage control activities, and other legal furbearer trapping in Maine. The permit allows incidental trapping of 195 lynx (including 3 mortalities) over a 15-year period. After two lynx were killed in killer-type traps in 2014, MDIFW imposed additional emergency trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx (see Other Factors in section 4.1.1 below). The regulations now require exclusion devices on most killer-type traps, prohibit the use of drag sets on foothold traps, address specific trap types and sets, prohibit visual use of bait and visual attractants, multiple swivels on chains, and require reporting of incidental captures. The trapping incidental take permit is currently being litigated in Federal court. The MDIFW also is responsible for implementing the Maine Endangered Species Act (http://www.mainelegislature.org/legis/statutes/12/title12sec12803.html; MDIFW 2009, p. 9). Although the lynx is not State-listed as threatened or endangered because its population is estimated to exceed the State's listing threshold, it is considered a species of special concern (MDIFW 2011, p 2). The MDIFW works collaboratively with the Service to conduct research and monitor lynx populations and habitats, and it recommends voluntary forest management activities to promote a sustainable supply and large, connected, and widely-distributed blocks of dense, young spruce-fir stands and to conserve large blocks of unfragmented forestland in northern and western Maine (MDIFW 2011, p. 3).

Unit 2: Northeastern Minnesota - Although lynx were unprotected and had a bounty placed on them in Minnesota prior to 1965, lynx trapping and hunting have been prohibited in Minnesota since 1984 (Moen *in* Lynx SSA Team 2016, p. 19). Overlapping the Northeastern Minnesota SSA unit, the State Department of Natural Resources (MNDNR) has identified a specific "Lynx Management Zone" (LMZ) for which it has promulgated and enforces special trapping regulations for other furbearers in lynx habitat. The MNDNR has modified trapping regulations within the LMZ to minimize the incidental take of lynx during the legal trapping of other furbearers. The regulations address specific trap types and sets, prohibit the use of certain baits and visual attractants, and require reporting of any incidentally trapped lynx to DNR conservation officers within 24 hours (pages 52-54 at: http://files.dnr.state.mn.us/rlp/regulations/hunting/2013/full_regs.pdf). In 2015, the MNDNR issued emergency trapping rules in the LMZ mandating additional restrictions on the types of traps that may be used (MNDNR 2015, entire) to further reduce the likelihood of incidentally

trapping lynx. Minnesota DNR is under a Federal court order to develop an incidental take plan for lynx and plans to seek an incidental take permit from the Service for lynx trapped incidental to other legal furbearer trapping. Like Maine, Minnesota has a State Endangered Species Statute (84.0895) which requires the Minnesota DNR to adopt rules designating species meeting the statutory definitions of endangered, threatened, or species of special concern (State of Minnesota 2016, entire). The Statute also authorizes the DNR to adopt rules that regulate treatment of species designated as endangered and threatened. Also like Maine, Minnesota has designated the lynx a species of special concern (MNDNR 2013, p. 2), and coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats.

Unit 3: Northwestern Montana/Northeastern Idaho - Lynx are designated as a species of concern (S3) by the State of Montana and a species of greatest conservation need (S1) by the State of Idaho (ILBT 2013, p. 57). The harvest of lynx was prohibited in Idaho and Montana beginning in 1996 and 1999, respectively. Both States participate in the CITES Export Program for bobcats, and both have promulgated and enforce special regulations for the legal trapping of other furbearers in areas occupied by lynx. In its trapping regulations, Idaho Fish and Game (IDFG) provides information on how to distinguish between bobcats and lynx and provides guidelines to reduce injury and minimize non-target catches, including lynx (IDFG 2016, pp. 36-37). Guidelines recommend (1) a minimum 8-pound pan tension on foothold traps set for wolves, (2) specific trap types and sets for other furbearers, and (3) bait and habitat considerations when making sets. Trappers are also required to contact IDFG or local sheriff's offices to assist with the safe release of incidentally trapped lynx. In response to a lawsuit after several lynx were incidentally trapped recently in northern Idaho, the U.S. District Court for the District of Idaho ordered the State to submit "a plan to protect the lynx from future incidental takes in the Panhandle and Clearwater (northern) Regions of Idaho" (U.S. District Court ID 2016, pp. 25-26). The plan has not yet been completed and negotiations between the State and the court are ongoing (Sallabanks 2016, *pers. comm.*). To minimize and track the incidental capture of lynx, Montana Fish, Wildlife, and Parks (MTFWP) has promulgated an evolving set of trapping regulations and reporting requirements since the DPS was listed (MTFWP 2016, pp. 7-10), including significant changes in 2008 that reduced the reported rate of incidental lynx captures from 1.6 per year in 2000-2007 to 0.4/year in 2008-2015 (MTFWP 2016, p. 5). In 2015, the Federal District Court of Montana approved a settlement agreement reached between the State of Montana and conservation groups aimed at protecting lynx from trapping. The case is now dismissed in accordance with the agreement, which requires Montana to implement a set of reasonable restrictions on trapping in lynx habitat. Currently, these regulations identify designated lynx protection zones (LPZs) and define acceptable trapping methods for public lands within them, which (1) prohibit the use of lethal (non-relaxing) snares for bobcats, (2) specifies the types of sets and baits or attractants that may be used for marten, fisher, and other furbearers where lynx occur, (3) requires a minimum 10-pound pan tension on foothold traps set for wolves, and (4) requires that any incidentally trapped lynx must be released unharmed if possible and reported to MTFWP (MTFWP 2016, pp. 7-10). MTFWP is also responsible for implementing Montana's Nongame and Endangered Species Conservation Act

(http://leg.mt.gov/bills/mca/87/5/87-5-103.htm; https://www.animallaw.info/statute/mt-endangered-species-chapter-5-wildlife-protection#87-5-107).

Unit 4: North-central Washington - Lynx harvest was prohibited in Washington in 1991, and the lynx was listed as a State threatened species in 1993 and proposed for uplisting to endangered in 2016 (Lewis 2016, pp. *iii*, 1). Under the State's Endangered Species Program, the Washington Department of Fish and Wildlife (DFW) developed a Lynx Recovery Plan (http://wdfw.wa.gov/publications/00394/) and a Status Report (http://wdfw.wa.gov/publications/01521/), and it prepares annual reports to update population and habitat information for the species. The DFW also coordinates with the Service and other agencies to conduct research and monitor lynx populations and habitats. Additionally, the use of body-gripping traps (foothold, conibear, snares, etc.) for trapping other furbearers is prohibited in Washington (except for damage control or nuisance wildlife, which requires special permits). This avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

Unit 5: GYA (Southwestern Montana and Northwestern Wyoming) - See Unit 3, above, for summary of Montana's special trapping regulations to minimize incidental take of lynx. Lynx in Wyoming were offered full protection from trapping and hunting beginning in 1973, and they are designated by the State as a species of greatest conservation need (ILBT 2013, p. 57). The Wyoming Game and Fish Department (WGFD) also participates in the CITES Export Program for bobcats.

Unit 6: Western Colorado - Lynx harvest was prohibited in Colorado in 1970 and the lynx was listed as endangered in the State in 1973. Colorado participates in the CITES Export Program for bobcats, provides information to trappers and hunters on how to distinguish between lynx and bobcats, and requires immediate release of uninjured incidentally trapped lynx as well as reporting of any (uninjured, injured, or killed) incidentally trapped lynx (CPW 2015b, pp. 6-7). Colorado law prohibits the use of foothold or conibear traps and snares for trapping, which avoids the potential for lynx to be incidentally captured in traps set legally for other animals.

State Forest Management Regulations - Timber harvest and other forest management activities on State and private lands are governed by State regulations. Because these activities have the potential for beneficial, benign, or adverse impacts to lynx habitat depending on methods, implementation, and conservation measures, State forestry regulations may influence lynx populations, particularly where substantial amounts of lynx habitat occur on State and private lands. Below, we provide an overview of the forest management regulations in the SSA geographic units and briefly discuss their potential influences on lynx habitat. Additional details on the current and likely future influences of these regulations on lynx populations are provided below in chapters 4 and 5, particularly for the Maine and Minnesota units, where State and private lands constitute the majority of lynx habitats.

Unit 1: Northern Maine - State and private lands constitute seven percent and 90 percent, respectively, of this SSA unit, with the vast majority of private lands managed for commercial timber production. As described above in section 2.3.2.2 and in more detail below in sections

4.2.1 and 5.2.1, the current abundance of lynx in northern Maine is attributable to the landscape-scale clear-cutting that occurred on private timber lands in the 1970s and 1980s in response to an extensive spruce budworm outbreak, which resulted in the recent unnaturally large amount of young (15 to 35 years post-harvest) regenerating forest in prime hare habitat condition. The amount and distribution of this post-clear-cut high-quality hare habitat likely peaked in the late 1990s, when 20-25 percent of the forest in Maine was in an early regeneration stage. The amount of young, regenerating forest at that time was three to eight times higher than natural historical conditions, when only three to seven percent of stands were likely in such condition at any given time (68 FR 40094). Current timber harvest and management on State and private lands in Maine are governed by the Maine Forest Practices Act of 1989 and administered by the Maine Forest Service within the Department of Agriculture, Conservation & Forestry to regulate, among other things, the size, arrangement, regeneration, and management of clearcuts (MEDACF 2014, pp. 42-45). Under the Act, small (up to 250 acre) clear-cuts are still permitted, but require special permits. Because of this regulatory burden and public referendums opposed to clear-cutting, the extensive clear-cutting of the past has largely been replaced by various forms of partial harvest techniques; many of which are unlikely to maintain the current unnaturally high amount and distribution of high-quality hare habitat. The consequences of this large-scale shift in forest management on Maine's current lynx population, which is likely much larger than was possible under the natural historical disturbance regime, are discussed below in sections 4.1.1 and 5.1.1, along with other programs that may influence private lands forest management in this unit.

In Maine, there are no long term management agreements in place on private lands to assure management of lynx. In 2006 and 2007, the Natural Resource Conservation Service (NRCS) provided funds to Maine for a pilot Healthy Forest Reserve Program (HFRP) specifically to manage for Canada lynx and American marten. Five landowners enrolled in the program, but one withdrew. The remaining four landowners were provided funding to develop lynx plans on a total of about 630,000 acres (about 10 percent of the critical habitat area). These landowners selected one or two township-sized (23,000 acre) areas within their ownerships to develop and implement a lynx management plan. Thus, about 161,000 acres within the larger area was targeted for managing lynx. All four landowners completed lynx plans using guidelines in the Service's *Canada lynx management guidelines for Maine* (McCollough 2007). NRCS contracts with the landowners last 10 years and will expire in 2016 and 2017. The HFRP described an opportunity for enrollees to apply for Safe Harbor Agreements when their contracts expired, although none have indicated an interest yet in doing so. Management plans were written for a 70-year period so some landowners may continue voluntary lynx management activities. Many private landowners in Maine are enrolled in forest certification programs; the Sustainable Forestry Initiative (SFI) and Forest Stewardship Council (FSC). Both programs require landowners to protect endangered species and their habitats, but there are not specific recommendations pertaining to lynx. About 2.5 million acres in northern Maine is under conservation easement (http://web.colby.edu/stateofmaine2012/state-of-large-landscape-conservation-in-maine/ last accessed 8.18.2016), but easements do not require management prescriptions or commitments for lynx. To our knowledge, there are no private landowners in

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Maine who have committed to long-term or permanent protection and creation of lynx habitat according to the Service's lynx management guidelines or LCAS.

State lands include Baxter State Park (~200,000 acres) and the various lots owned and managed by the Maine Bureau of Parks and Lands (MBPL). Most of Baxter State Park is managed as wilderness area, and lynx sightings in the Park are rare because most of the park is mature forest. MBPL integrated resource policy requires that they promote the conservation of Federally listed species, but so far no lynx management plans have been developed. Mitigation for Maine Department of Inland Fisheries and Wildlife's incidental take permit for trapping requires management of 6,200 acres of lynx habitat within a 22,046-acre habitat management area on the MBPL's Seboomook Unit for a 15-year period.

Unit 2: Northeastern Minnesota - State and private lands constitute about 36 percent and 16 percent, respectively, of this SSA unit. The Minnesota Department of Natural Resources (MN DNR) Division of Forestry regulates timber harvest and management on State and private lands. Under the Sustainable Forest Resources Act of 1995 (revised most recently in 2014 [MFRC 2014a, p. 1]), the Minnesota Forest Resources Council (MFRC) has developed voluntary guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) that are intended for private and State landowners and include some general recommendations for wildlife including lynx. However, because they are voluntary, the extent to which these guidelines benefit lynx is uncertain (see sections 4.1.2 and 5.1.2 below).

Unit 3: Northwestern Montana/Northeastern Idaho - State and private lands constitute about four percent and eight percent, respectively, of this SSA unit and almost all are in the Montana portion of the unit. The Montana Department of Natural Resources and Conservation (MTDNRC) administers several laws pertaining to forest practices on State and private lands. These laws are intended to protect streamside management zones, reduce fire hazards, and provide BMPs to minimize non-point source water pollution (http://dnrc.mt.gov/divisions/forestry/forestry-assistance/forest-practices, accessed July 18, 2016). Although these laws may provide indirect benefits to lynx and other wildlife, they do not include specific measures to conserve or avoid impacts to lynx habitats. However, the MTDNRC and the Service collaborated on a multi-species habitat conservation plan (HCP) for forested State Trust lands that includes a Lynx Conservation Strategy to minimize impacts of forest management activities on lynx and describes conservation commitments that are based on recent information from lynx research in Montana (USFWS 2104, pp. 22-23; 79 FR 54835-54837). This HCP covers about 64 percent of the State lands in this SSA unit, regulates activities primarily associated with commercial forest management to conserve lynx foraging, denning, and connectivity habitats, and includes a 50-year commitment (79 FR 54835-54836). Additional details on this HCP and other programs for conserving lynx habitats on State and private lands in this unit are provided in section 4.1.3 below.

Unit 4: North-central Washington - State and private lands constitute about eight percent and 0.3 percent, respectively, of this SSA unit and most are State Trust lands in the Loomis State Forest, which accounts for all 426 km^2 (164 mi^2) of State lands in this unit. The Washington

Department of Natural Resources (WADNR) administers rules guiding forest practices, such as timber harvests and road building, on State, private, and tribal forests in Washington. The Forest Practices Board, an independent State agency, adopts forest practices rules to protect water quality, fish habitat, other public resources and guide DNR's permitting process for timber harvests and other forest practices statewide. The WADNR developed a Lynx Habitat Management Plan (LHMP) for WDNR-managed lands distributed throughout north-central and northeastern Washington in areas delineated as Lynx Management Zones in the Washington State Lynx Recovery Plan (Stinson 2001, entire; Washington DNR 2006, entire). The WADNR LHMP guides timber harvest and other vegetation management on these lands, including the part of the Loomis State Forest that occurs in this unit, with the goal of creating and preserving quality lynx habitat through its forest management activities. Additional information on the LHMP is provided in sections 4.1.4 and 5.1.4 below.

Unit 5: GYA - State and private lands constitute about 0.3 percent and just over two percent, respectively, of this SSA unit and, combined, likely have little influence on lynx population persistence. Forestry regulations for the Montana portion of this unit (26 percent) are described above. In the Wyoming portion (74 percent of the unit), the Wyoming State Forestry Division is responsible for the management of forested trust land across the state, including timber management and harvest, for long term forest health and productivity. Although the Division's programs may provide some indirect benefits to lynx, they do not include species- or habitat-specific regulations or conservations measures.

Unit 6: Western Colorado - State and private lands constitute about 0.6 percent and over 9nine percent, respectively, of this SSA unit. The Colorado Department of Natural Resources and the State Division of Forestry oversee forest management activities on State and private lands in Colorado.

Tribal Management: Tribal lands encompassed by SSA geographic units include those of the Passamaquoddy Tribe and the Penobscot Indian Nation in Maine (248 km^2 [96 mi^2] in Unit 1), Grand Portage Band of Lake Superior Chippewa in Minnesota (202 km^2 [78 mi^2] in Unit 2), and the Confederated Salish and Kootenai Tribes of the Flathead Nation - Flathead Reservation in Montana (958 km^2 [370 mi^2] in Unit 3). Tribal management of these lands is expected to benefit lynx and lynx habitats. No tribal lands occur within SSA units 4, 5, or 6.

Unit 1: Northern Maine - Tribal lands represent less than one percent of this unit. The Passamaquoddy Tribe has lands enrolled in the Healthy Forest Reserve Program, described above. The Passamaquoddy Tribe's stated environmental mission is "...to protect the environment and conserve natural resources within all Passamaquoddy lands, waters, and the air we share" (Passamaquoddy Tribe 2014, entire). That of the Penobscot Indian Nation Department of Natural Resources is "...to manage, develop and protect the Penobscot Nation's natural resources in a sustainable manner that protects and enhances the cultural integrity of the Tribe" (Penobscot Indian Nation 2014, entire). Hunting, trapping or possessing lynx are prohibited in accordance with the Penobscot Indian Nation Chapter VII Inland Fish and Game Regulations – Section 204 (Penobscot Indian Nation 2012, p. 15).

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Unit 2: Northeastern Minnesota - Tribal lands of the Grand Portage Indian Reservation and the Bois Forte Indian Reservation—Vermillion Lake District represent one percent of this SSA unit. The Grand Portage Band of Chippewa has been actively working on lynx conservation since 2004. In October 2007, the Band hosted an international conference on lynx research and conservation where more than 50 researchers from the United States and Canada presented results of research on lynx diet, habitat, and management. Additionally, on-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire).

Unit 3: Northwestern Montana/Northeastern Idaho - Tribal lands of the Confederated Salish and Kootenai Tribes of the Flathead Nation, Flathead Reservation represent nearly four percent of this SSA unit. The mission statement of the Tribes' Fish, Wildlife, Recreation and Conservation Division is "...to protect and enhance the fish, wildlife, and wildland resources of the Tribes for continued use by the generations of today and tomorrow" (Confederated Salish and Kootenai Tribes 2014a, entire). An objective of the Tribes' Tribal Wildlife Management Program Plan is to ". . . develop and implement habitat management guidelines for Canadian lynx in coordination with the Forestry Department as specified in the Forest Management Plan" (Confederated Salish and Kootenai Tribes. 2014b, p. 5). The Forest Management Plan states that "Standards for lynx management and habitat protection are set forth in the Canada Lynx Conservation Assessment and Strategy. This strategy guides land management activity in lynx foraging and denning habitat. Lynx occurrence and populations will continue to be monitored on the Reservation" (Confederated Salish and Kootenai Tribes 2000, p. 285).

In summary, a variety of State wildlife and forestry regulations and conservation efforts, along with Tribal resource management objectives, influence activities in lynx habitats across the range of the DPS. While many of these clearly benefit lynx habitats and likely contribute to the persistence of resident populations, uncertainty remains regarding the effectiveness of some regulations and voluntary programs or measures in maintaining or restoring lynx habitats. This may be especially important with regard to timber management regulations and programs on private lands, which constitute the majority of lands in the Northern Maine geographic unit and a substantial amount of the Northeastern Minnesota unit.

3.2 Climate Change

In 2014, the International Panel on Climate Change (IPCC) released its Fifth Assessment Report, which represents the current scientific consensus on global and regional climate change and the best scientific data available in this rapidly changing field. The Fifth Assessment Report largely reaffirms the conclusions of previous reports that the global climate is warming at an accelerating rate and that this warming is largely the result of human activities and the associated release of carbon dioxide and other greenhouse gases into the atmosphere (IPCC 2014a, entire).

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''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is a result of natural variability, human activity, or both (IPCC 2007a, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007a, pp. 8–14, 18–19). In our analyses, we weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

The IPCC's Fifth Assessment Report concludes that the strongest and most comprehensive evidence of the impacts of climate change is in natural systems, where many species have responded by shifting their geographic ranges, seasonal activities, migration patterns, abundances, and species interactions (IPCC 2014a, p. 4). The report also concludes that projected climate change during and beyond the 21st Century will increase extinction risk for many terrestrial and freshwater species (IPCC 2014a, pp. 14–15). In North America, observed impacts attributable to climate change that may affect lynx habitats and distribution include upslope and northward shifts in species distributions across multiple taxa, and increased wildfire activity, fire frequency and duration in boreal and subarctic conifer forests of Canada and the western U.S. (IPCC 2014a, p. 31).

At the time of listing, the Service determined there was no evidence to support global warming as a threat to lynx (65 FR 16068-16069). In the 2003 remanded determination, we concluded that the best information available at that time regarding the potential impact of climate change on lynx (warming leading to long-term reductions in snow depths needed to support lynx in the eastern U.S. and eastern Canada south of the St. Lawrence Seaway; Hoving 2001, pp. 72-75) was speculative and did not demonstrate a threat to lynx (68 FR 40083, 40098). In the 2005 recovery outline for the DPS, the Service acknowledged that continued climate warming was likely to negatively affect the boreal forest ecosystem for which lynx are highly adapted, eventually causing it to recede north and/or to higher, colder elevations, potentially resulting in a substantial reduction or even elimination of lynx habitats from the contiguous U.S. (USFWS 2005, pp. 11, 14). In the 2009 critical habitat rule, the Service acknowledged that new science concerning climate change was available, and that climate change may pose a risk to the future conservation of lynx (74 FR 8617, 8621). In the 2014 revised critical habitat rule, we concluded that recent information on regional climate changes and potential effects to lynx habitat (e.g., Knowles *et al.* 2006, pp. 4545–4559; Carroll 2007, pp. 1098–1102; Danby and Hik 2007, pp. 358–359; Gonzalez *et al.* 2007, entire; Iverson *et al.* 2008, pp. 390–400; Beckage *et al.* 2008, entire; Burns *et al.* 2009, p. 31; Johnston *et al.* 2012, pp. 6–13) suggested that climate change is likely to be a significant issue of concern for the future conservation of the lynx DPS (79 FR 54811). Specifically, climate models project reductions in the extent of boreal forest habitats and snow conditions needed to support lynx throughout the DPS, with both features modeled to

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migrate to higher elevations (in locations where this is possible) and northward in latitude. This would result in fewer, smaller, and more fragmented and isolated areas capable of supporting resident lynx and, therefore, smaller and more isolated lynx populations that would likely be more vulnerable to stochastic environmental and demographic events (79 FR 54811). Climate change also may have synergistic effects with other stressors (e.g., forest insect outbreaks and wildfire frequency, size, and intensity) that could further reduce and isolate lynx populations within the DPS and reduce connectivity to lynx in Canada. Climate change may also affect human interactions in the DPS that could benefit or stress lynx (e.g., growing older forests to increase carbon sequestration, developing biomass and wind energy in lynx areas).

Lynx biologists identify climate change as the most important and overarching factor influencing resiliency of the DPS (Lynx SSA Team 2016, pp. 14, 17, 19, 21-22, 35-47, 50, 53-57; ILBT 2013, pp. 43, 48, 53, 55, 63, 66, 69-71, 98). Climate change is likely to be exacerbated at the southern edge of the range where habitat and snow conditions are patchy and becoming increasingly marginal for the continued existence of lynx (Gonzalez *et al.* 2007, p. 8). Across North America, a significant increase in proportion of winter precipitation falling as rain rather than snow has resulted in reduced persistence of the winter snowpack (Dyer and Mote 2006, entire), increased snow density (Hodgkins and Dudley 2006, entire), and decrease in the extent of deeper snowpacks (Dyer and Mote 2006 p. 1; Brown 2000, pp. 2347-2354). Climate change models suggest that future snow cover in the contiguous U.S. will be further reduced in extent and distribution (McKelvey *et al.* 2011, pp. 2892-2896).

Warming and more frequent winter thaws are contributing to changes in snowpack structure, namely replacing deep, fluffy snow with harder, crustier snow. These suboptimal snow conditions are expected to occurr at higher latitudes (Callaghan *et al.* 2011, entire) and higher elevations in the Rockies (Abatzoglou 2011, pp. 1138-1141). The frequency of winter warm spells is correlated to the hardness of the snow surface, sinking depth, and, in turn, influence the hunting efficiency of lynx (Stenseth *et al.* 2004, p. 10633). As the climate warms, winter temperatures are rising above freezing more often. This results in more rain on snow events and winter thaws that change the structure of the snowpack; larger grain size, basal ice layers, depth hoar (weak layers in the snowpack), and slip planes (crusts and ice layers within the snowpack;Callaghan *et al.* 2011, p. 23). Hard snow surfaces (crust) and other structure in the snowpack are believed to reduce the competitive advantage of lynx over bobcats and other mesocarnivore competitors and predators.

Although it is believed that high elevation areas in the West may provide snow refugia for lynx (Lynx SSA Team 2016, p. 45), these areas will also be affected. Mountainous regions in the western U.S. have historically been snow-covered from November through March. By 2050, the length of snowfall-conducive temperatures over many western mountain ranges will be reduced from approximately five months (November–March) to approximately three months (December-February) of the year (Klos *et al.* 2014, p. 4566). Many relatively large areas that contain lower relief, mid-elevation mountain ranges will likely shift relatively quickly into new precipitation phase regimes (e.g., the Northern Rockies, North Cascades; Klos *et al.* 2014, p. 4566). The interior northwestern U.S. shows a greater sensitivity of its strongly snow-dominated areas to

warming because much of the region is characterized by relatively warm winter temperatures and by mainly mid-elevation mountain ranges. The climatic rain-snow transition zone will move up in altitude and north in latitude.

It is possible that in high elevation areas of the DPS range in the West, snow conditions suitable for lynx may move up slope at a faster rate than boreal forest habitat will migrate, providing a mismatch of these important habitat elements for lynx. During prehistorical periods of warmer climate, the alpine treeline ecotone (upper elevation of lynx boreal habitat) and deciduous-boreal forest ecotone (lower elevation of lynx boreal habitat) have readily moved upslope in both the northern (Kearney and Luckman 1983) and Southern Rockies (Legg and Baker 1980). Boreal treelines in Scandinavia moved upslope an average of 40 m (but in some locations up to 100 m) during a recent 50-year period of warming (Kullman 1990). However, despite recent warming, the alpine treeline in North America has thus far remained relatively static (Butler *et al.* 1994). Upslope migration of the treeline of boreal forest may be limited by high winds, desiccation, and soil depth not conducive to colonization by conifers. Upslope migration of boreal forest will occur either gradually or as a series of scattered, rapid advances as climate thresholds are crossed (Kupfer and Cairns 1996, p. 259-261). At lower elevations, the upslope movement of the deciduous-boreal ecotone is limited by an isocline of excessively cold winter temperatures (generally -40C), moisture (cloud, fog line), and acidic soils (Kupfer and Cairns 1996, p. 263-264). The rate that boreal forest will retreat upslope is highly speculative depending on how climate change will affect complex moisture and temperature regimes, and there could be a lag time before these community types move up slope (Kupfer and Cairns 1996, p. 268). In the Yukon, upslope migration of spruce-fir seemed to be triggered by climate thresholds and was characterized by slow, gradual change followed by rapid advances (Danby and Hik 2007, p. 361). However, in Vermont, the northern hardwood-boreal ecotone moved upslope 91 to 119 m between 1962 and 2005 consistent with rapidly increasing cloud ceilings in the Northeast, which is believed to be closely associated with this ecotone transition (Beckage *et al.* 2008, pp. 4200-4201).

In contrast, there have been no lag time or thresholds slowing changes in the precipitation and snow regime. Much of the Rockies have already experienced declines in spring snowpack in response to climate change, especially since midcentury, despite increases in winter precipitation in many places (Mote *et al.* 2005, entire; Scalzitti *et al.* 2016, pp. 5367-5368). Some mountainous regions are warming at a faster rate than global land averages (Rangwalla and Miller 2012, entire). It is likely that the losses in snowpack observed to date will continue and even accelerate (Hamlet and Lettenmaier 1999; Payne *et al.* 2004), with faster losses in milder climates like the Cascades and the slowest losses in the high peaks of the northern Rockies and southern Sierras. For every 1 °C increase in temperature, snowline increases about 150 m in elevation (Beniston 2016, p. 106). If greenhouse gas emissions continue at the current rate, by 2100, the altitude above which it snows and below which it rains will climb as much as 800 feet in the Colorado Rockies, by 1,400 feet in the Rockies of Idaho and Wyoming, and the snow line will rise by an average of 950 feet across six Western mountain regions (Scalzitti *et al.* 2016, p. 1564). Thus, it is possible that boreal forest will persist for a while, but

deep, fluffy snow conditions will retreat upslope and preclude the use of boreal habitat by lynx and instead favor competitors such as bobcats.

The effects of climate warming are already occurring and have accelerated over the past three to four decades (Hansen *et al.* 2006, entire). Globally, greenhouse gas emissions are increasing and tracking levels predicted by models for high emissions scenarios (e.g., RCP8.5) (Peters *et al.* 2013; Friedlingstein *et al.* 2014, p. 709, 712; Fuss *et al.* 2014, p. 851; IPCC 2013, p. 180, 187-189). Analysis of paleoclimate indicates 20th century warming is likely to have been the largest of any century within the last 1000 years (Folland *et al.* 2001, pp. 99-101). These changes are predicted to continue and accelerate under future climate scenarios (Hall and Fagre 2003, Fig. 7). The range of warming projected over this century runs from 3.6 °F (2 °C) to 10.8 °F (6 °C) for North America, with warming higher than this average in areas that are inland, northerly, or mountainous.

Climate change is manifested in different ways throughout the northern contiguous United States and the lynx DPS. To date, the observed and predicted increases in surface temperatures have been greatest in the northern Rockies and Northeast (much of the lynx DPS) than elsewhere in the contiguous United States (IPCC 2014, pp. 12, 61, Lynx SSA Team 2016, pp. 14-15). Climate history and projections from regional climate models for regions associated with the lynx DPS units corroborate global models, and indicate that both eastern and western North America, including all portions of the lynx DPS, have warmed in the last century and are likely to warm 1.8 °F (1 °C) to 5.4 °F (3 °C) by the year 2050 (IPCC 2007b, p. 889). For example, in the Northern Rocky Mountains at Glacier National Park, mean summer temperatures have increased 3.0 °F (1.66 °C) between 1910 and 1980 (Hall and Fagre 2003, pp. 134–137) resulting in lower snowpack, earlier spring melt, and distributional shifts in vegetation (Hall and Fagre 2003, pp. 138–139; Fagre 2005, pp. 4–9).

Climate change is diminishing snow conditions (reduced depth, quality, persistence) considerably throughout the DPS. The strong warming in recent decades corresponded to a large decline in snow cover in North America, particularly in the mountains of the western U.S. (Mote *et al.* 2005, p. 47-48). In most mountain ranges, relative declines vary from minimal at ridgetop to substantial at snow line. Temperature has increased more in the winter than summer (Knowles *et al.* 2006), which has increased the amount of winter precipitation falling as rain instead of snow throughout the DPS (Huntington *et al.* 2004, entire; Knowles *et al.* 2006, entire; Feng and Hu 2007, entire). The rate of decline in the snowpack of the northern Rockies is unprecedented in the last 1000 years (Pederson *et al.* 2011, entire). An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13).

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Climate change is expected to substantially reduce the amount and quality of lynx habitat in the contiguous U.S., with patches of high-quality boreal and subalpine forest habitat becoming smaller, more fragmented, and more isolated (Carroll 2007, pp. 1099–1100; Johnston *et al.* 2012, p. 11). Various forms of snow compaction and structure within the snowpack (see above) give a competitive advantage to bobcats and other predators/competitors with higher foot loading that would normally have difficulty traveling and hunting efficiently in deep, fluffy snow conditions (Murray and Boutin 1991; Murray *et al.* 1994; Kolbe *et al.* 2010). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103). These trends indicate the range of the lynx in the DPS is likely to contract as a direct result of climate change. Because of climate change and other stressors, lynx biologists believed that only one to three of the six units may persist to the end of the century (Lynx SSA Team 2016, p. 48).

Near-term effects of climate warming on lynx are more certain than long-term effects. Lynx experts anticipate a downward trend for the probability of persistence of lynx in all six geographic units primarily because of the effects of climate warming (Lynx SSA Team 2016, pp. 35-47). The rates of change and magnitude of effects of climate warming is difficult to predict. Climate change is anticipated to affect each unit differently as summarized below.

Climate change is affecting many of the requirements necessary for the continued existence of lynx in the DPS. Climate warming will continue to stress populations into the foreseeable future. Direct effects to lynx, hares, and their habitat that are occurring or can be reasonably anticipated include 1) range contraction, 2) reduction in the periodicity and amplitude of the hare cycle, 3) reduction in snow conditions necessary to give lynx a competitive advantage, 4) reduction in hare habitat quality and populations, 5) reduction in the amount of lynx and hare habitat in the U.S., 6) changes in the frequency and pattern of disturbance events, 7) introduction of disease and parasites, and 8) reduced gene flow. Synergistic effects between these factors and other stressors (e.g., forest management, trapping, development) may intensify their effects (Carroll 2007). Diminished snow, increasing drought and fire, and increased forest pests and disease are believed to currently be the most important stressors for lynx in the DPS, but it is possible that other pathways are, or may become, equally important. Over the next decades, southern lynx populations will continue to be affected by climate change and associated shifts in habitat, prey base, and competition. The extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in the contiguous U.S. (Murray *et al.* 2008).

Range Contraction in the DPS - In response to climate change, lynx range in the DPS is expected to contract as a result of boreal habitat shifting to higher elevation (Danby and Hik 2007, pp. 360-362) and northward shifts in latitudinal distribution of boreal habitat and snow conditions (Sturm *et al.* 2001, pp. 342-342; Gonzalez *et al.* 2010, pp. 761-766; Koen *et al.* 2015. p. 528; ILBT 2013, p. 69). For example, lynx distribution in southeastern Ontario has shifted northward >175 km over the past 40 years (Koen *et al.* 2014a, pp. 757-758). Habitat patches will become smaller, more fragmented and isolated (Carroll 2007, pp. 1099-1100; Johnston *et*

al. 2012, p. 11), bobcat distribution will expand northward (see below), and lynx will become more vulnerable to stochastic and environmental and demographic effects because of smaller population sizes and increased isolation.

Reduction in Periodicity and Amplitude of the Hare Cycle - Climate change is altering large-scale climate systems such as the North Atlantic Oscillation, Southern Oscillation, Pacific North American Index, and North Pacific Index which, in turn, affect patterns of temperature and snow in North America (Stenseth *et al.* 2003, entire). Climate change-induced disruptions are believed to have caused the collapse of cycles in voles, lemmings, and snowshoe hare populations (Ims *et al.* 2008, p. 81; Krebs *et al.* 2010, pp. 484-488; Cornulier *et al.* 2013, entire). The geographical borders between cyclic and noncyclic populations are shifting, and the spatial extents of regions that have cycles are shrinking. The collapse of cycles in herbivores with high-amplitude population cycles also would imply collapses of important ecosystem functions such as pulsed flows of resources and disturbances throughout the ecosystem, including declines in predator communities (Schmitz *et al.* 2003, p. 1202; Ims *et al.* 2008, p. 85). A common denominator of cycles that exhibit spatial gradients, such as the more pronounced snowshoe hare cycles in the northern part of its North American range, is that the cycles seem to fade as winters become shorter (Ims *et al.* 2008, p. 81).

Changes in large-scale climate systems have already influenced the climate and snow conditions throughout the geographic range of the lynx in North America (Stenseth *et al.* 1999, entire; Brown 2000, pp. 2347-2354; Krebs *et al.* 2001a, p. 34). Yan *et al.* 2013 (p. 3269) provide the first evidence of the negative effects of climate warming on hare-lynx cycles in Canada. The authors concluded that climate forcing is not only essential in producing sustained cycles, but also in modifying the cycle intervals (Yan *et al.* 2013, p. 3269). Greatly reduced lynx fur harvests in Canada beginning in the mid-1980s may be linked to climate warming (Yan *et al.* 2013, p. 3269). With more pronounced troughs in hare abundance cycles, lynx populations will decline (Hone *et al.* 2011, p. 424). Diminished lynx populations in the core of the range in Canada is a concern because most of the populations of lynx in the DPS are believed to be dependent on periodic immigration from Canada for demographic persistence and genetic stability (McKelvey *et al.* 2000a, pp. 232-242; 2000b, pp. 32-34; Schwartz *et al.* 2002, entire; USFWS 2005, p. 2; ILBT 2013, pp. 34, 42, 47, 54, 60, 65; Squires *et al.* 2013, p. 187; 79 FR 54789, 68 FR 40091, 40097-40100). If diminished amplitude of the hare cycle in Canada persists, it will likely translate into a reduced potential for lynx to expand into new or unoccupied habitat in Canada or the adjoining U.S. (ILBT 2013, p. 69).

Reduction in Snow Conditions that are Necessary to Provide Lynx a Competitive Advantage - Climate-induced changes in snow depth and quality are critical because they reduce the extent of deep, fluffy snow habitat available to lynx (Knowles *et al.* 2006, p. 4557; Carroll 2007, p. 1103; Gonzalez *et al.* 2007, pp. 7-8; McKelvey *et al.* 2011, pp. 2893-2895; ILBT 2013 p. 69). Across their worldwide distribution, lynx rely on deep, powdery and persistent snow because they restrict potential lynx competitors such as bobcat or coyote and predators such as fishers and cougars from effectively encroaching on or hunting hares in winter lynx habitat (Peers *et al.* 2016, entire; 79 FR 54809).

Warmer winter temperatures are reducing snowpack in all portions of the lynx DPS through a combination of a higher proportion of precipitation falling as rain and higher rates of snowmelt during winter (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Hoving 2001, pp. 73–75; Mote 2003a, p. 3–1; Christensen *et al.* 2004, p.347; Knowles *et al.* 2006, pp. 4548–4549). These trends are expected to continue with future climate warming (Hamlet and Lettenmaier 1999, p. 1611; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 48; IPCC 2007b, p. 850). The IPCC (2007b, p. 850) concludes that "snow season length and snow depth are very likely to decrease in most of North America except in the northernmost part of Canada where maximum snow depth is likely to increase." Shifts in the timing of the initiation of spring runoff toward earlier dates in western North America are also well documented (Hamlet and Lettenmaier 1999, p. 1609; Brown 2000, p. 2347; Cayan *et al.* 2001, pp. 409–410; Christensen *et al.* 2004, p. 347; Mote *et al.* 2005, p. 41; Knowles *et al.* 2006, p. 4554). In addition, a feedback (albedo) effect is likely to accelerate the rate of loss of snow cover because of the reflective nature of snow and the relative heat-absorbing properties of non-snow-covered ground. This feedback effect causes the greatest warming to occur at the interface of snow-covered and exposed areas, increasing the rate at which melting occurs in spring (Groisman *et al.* 1994a, pp. 1637–1648; Groisman *et al.* 1994b, pp. 198–200). This effect has led to the average date of peak snowmelt to shift 3 weeks earlier in spring in the Intermountain West (Fagre 2005, p. 4). This albedo effect is further exacerbated by atmospheric soot and desert dust on the snow surface (Painter *et al.* 2007, entire; Qian *et al.* 2009, entire) and fire-darkened landscapes (Amiro *et al.* 2006, pp. 47-49). Snow accumulation and duration are expected to decline generally in the geographic areas that contain the central and eastern portion of the lynx DPS (IPCC 2007c, p. 891; Burns *et al.* 2009, p. 31). Because lynx require prolonged periods of deep fluffy snow, current habitats that lose this feature would decline in value for lynx (Hoving 2001, p. 73; Carroll 2007, p. 1092; Gonzalez *et al.* 2007, entire).

Reduced snow depth and duration may reduce lynx's competitive advantage over bobcats, which have similar ecology to lynx but are not as well-adapted to hunting hares in deep fluffy snow (Hoving 2001, pp. 23–24; Carroll 2007, p. 1102; ILBT 2013, pp. 69, 71). The bobcat is the closest related species to lynx in North America, and it outcompetes or displaces lynx wherever the two species overlap, at both broad (Peers *et al.* 2016, entire) and local (Parker *et al.* 1983; Robinson 2006, pp. 120-129) geographic scales. In areas where they do overlap, lynx are subjected to niche displacement to habitats of inferior quality, which probably limits lynx survival and productivity at the southern edge of their range (Peers *et al.* 2016, entire; Robinson 2006, pp. 120). Snow depth likely acts as a mediator of competition between the two species. Bobcats have a higher foot loading than lynx, are unable to hunt hares successfully in areas with deep, soft snow (Krohn *et al.* 2005, pp. 122-129, Hoving *et al.* 2005, entire), and experience high mortality in deep snow winters (Litvaitis *et al.* 1986, p. 116). Lynx have a low foot loading and long legs (Buskirk *et al.* 2000a, p. 90; Krohn *et al.* 2005, pp. 122-129) that gives them a competitive advantage over bobcats in deep, fluffy snow conditions. This has important implications for lynx persistence and range distribution at the southern edge of their range considering the current and projected changes in snow cover, stable or increasing bobcat populations in the DPS (Roberts and Crimmins 2010, p. 170), and the predicted northward

expansion of bobcats into areas currently occupied by lynx (Anderson and Lovallo 2003, p. 758; Lavoie *et al.* 2009, pp. 873-874; Roberts and Crimmins 2010, p. 172).

Buskirk *et al.* (2000a, entire) described exploitation (competition for food) and interference (avoidance) competition from bobcats and other species that may compete with lynx. Exploitation competition could contribute to lynx starvation and reduced recruitment. Of several predators examined (raptors, coyote, gray wolf, cougar, bobcat, and wolverine), coyotes were deemed the most likely to pose local or regionally important exploitation impacts to lynx. Coyotes, bobcats, and cougars are possibly capable of imparting interference competition effects on lynx. Interference would be most probable during summer and during winter in areas lacking deep, unconsolidated snow (ILBT 2013, p. 36). Cougars are also predators of lynx in the West (ILBT 2013, p. 35), but, like bobcats, cougars also have high foot loading, which limits their efficiency in deep, fluffy snow (Buskirk *et al.* 2000a, p. 90). Fishers are predators of lynx in Maine (Vashon *et al.* 2012), but their distribution and movements in winter are also limited by deep, unconsolidated snow (Krohn *et al.* 2005, entire).

The effects of lynx-bobcat hybridization on lynx populations in the DPS are uncertain. Bobcats have hybridized with lynx in Minnesota, Maine, and New Brunswick (Schwartz *et al.* 2004, entire; Homyack *et al.* 2008, entire), where low topographic relief and variability in winter severity may allow more interaction between the two species during the breeding season (ILBT 2013, p. 34). Hybrids were capable of reproducing successfully (Homyack *et al.* 2008, p. 507). The hybridization rate is currently low between the species (0.24 percent) but could increase as bobcat populations move north with climate change (Murray *et al.* 2007, p. 1465; Koen *et al.* 2015, p. 528).

Reductions in Hare Populations - In addition to affecting the synchronicity and amplitude of hare cycles, climate change will likely affect hare populations in other ways, especially at the southern extent of the range. Changing snow conditions may influence lynx hunting behavior and effectiveness. For example, hard-packed snow is reported to be associated with a higher kill rate of hares by lynx and coyotes than soft snow (Buskirk *et al.* 2000, p. 94; Stenseth *et al.* 2004, p. 10633). The higher kill rate could generate a numeric response by lynx and other hare predators (Hone *et al.* 2011, p. 420) that could drive hare populations to lower levels (Stenseth *et al.* 2004, p. 10633). Predator communities are more diverse at the southern part of the lynx range than in central Canada (Murray *et al.* 2008, pp. 1464-1465). The diverse predator community could explain why hare populations have declined and seem to remain low in Maine (Scott 2009, p. 43). Climate change will cause increased annual precipitation, periods of drought and extreme precipitation, and hotter summers across the northern tier of U. S. (i.e., throughout the DPS) in eastern North America (Jacobson *et al.* 2009, pp. 14-15, Romero-Lankao 2014, pp. 1452-1456). Increased precipitation may reduce hare numbers because the second litters of snowshoe hares have lower survival in wet summers (Meslow and Keith 1971, entire). However, because hares have two to four litters per summer, there is opportunity for compensatory survival of later litters if one is affected by weather (Krebs *et al.* 2014, p. 1043). Decreased hare survival may also be expected during prolonged hot, dry summer conditions. For example, hare densities in the GYA are believed to be low, in part, because of the dry conditions there

(Hodges *et al.* 2009). In dry western forests like those in the GYA, increased precipitation may result in more herbaceous forage and cover, which may promote hare survival and reproduction (Ivan *et al.* 2014, p. 590). Thus, climate change may have both positive and negative effects on hares.

Finally, the shorter duration and diminished snow cover in the DPS is causing an increasingly pronounced mismatch in the phenology of hare pelage change that may reduce hare survival (Mills *et al.* 2013, entire; Zimova *et al.* 2013, entire). Diminished snow duration by as much as 8 weeks by the end of the century could have population-level effects on hares at the southern edge of their range. Hares exhibit plasticity in the rate at which they can molt from white to brown in the spring, but not in the initiation date of color change or the fall transition from brown to white (Mills *et al.* 2013, pp. 7362-7363). Hares do not seem to compensate for mismatched pelage by changing their behavior related to concealment, thus predisposing them to predation (Mills *et al.* 2014, entire). There is wide variability in the timing of pelage change by individual hares within populations, and "mismatched" hares experience increased mortality rates (Zimova *et al.* 2016, p. 302). Under high emission scenarios, this could lead to an 11 percent decline in hare survival by mid-century and a 23 percent decline by late century. Diminished survival would lead to steep (high emissions) to moderate (medium-low emissions) declines in hare populations (Zimova *et al.* 2016, p. 304). It is also possible that this phenological mismatch may dampen hare cycles (Zimova *et al.* 2016, p. 305). Snow patterns have been proposed to potentially play a role in dampening cycles (Cornulier *et al.* 2013, pp. 64-65, Sultaire *et al.* 2016a, entire).

The range of the snowshoe hare is contracting northward in the southern part of its range in the contiguous U. S. because of changing snow conditions and reduced survival because of delayed pelage changes (Diefenbach *et al.* 2016, p. 245; Sultaire *et al.* 2016a, entire). In Wisconsin, snowshoe hare range has been contracting northward an average of 8.7 km per decade and will continue to recede northward with climate change (Sultaire *et al.* 2016a, entire). Loss of snow now contributes more than loss of habitat in determining the range of snowshoe hares in the Great Lakes region (Sultaire *et al.* 2016a, entire).

Reduction in Lynx and Hare Habitats - Climate change will diminish the amount of lynx habitat throughout the DPS by a) reducing the areas where snow conditions give lynx a competitive advantage over bobcats and other species, and b) reducing the amount of spruce-fir habitat required by snowshoe hares. An analysis of potential snow cover under a range of IPCC future climate scenarios and modeling of vegetation using a dynamic vegetation model indicates that potential lynx habitat could decrease by as much as two-thirds in the contiguous U.S. by the end of this century (Gonzalez *et al.* 2007, pp. 4, 7–8, 10, 13–14). Areas of contiguous spring snow cover will become smaller and more isolated throughout the Columbia, Upper Missouri, and Upper Colorado Basins, with greatest losses at the southern periphery, which likely is an indicator of the trajectory of lynx habitat (McKelvey *et al.* 2011). Deteriorating snow conditions caused by climate change is causing range contraction of snowshoe hares and the southern edge of their range (Sultaire *et al.* 2016b, pp. 900-904). Similarly, because of diminishing snow

resources, potential lynx habitat is diminishing in the northern Appalachians and small areas in the Canadian Maritime Provinces (Carroll 2007, p. 1093).

Changes in temperature and rainfall patterns are expected to shift the distribution of ecosystems northward and up mountain slopes (McDonald and Brown 1992, pp. 411–412; Danby and Hik 2007, pp. 358–359; IPCC 2007c, pp. 230, 232). As climate changes over a landscape, the ecosystems that support lynx are likely to shift, tracking the change of temperature, but with a time lag depending on the ability of individual plant and animal species to migrate (McDonald and Brown 1992, pp. 413–414; Hall and Fagre 2003, p. 138; Peterson 2003, p. 652). On the basis of the best existing data for 130 tree species in North America and associated climate information, and assuming no limitations to individual tree growth, McKenney *et al.* (2007) predicted that the average range for a given tree species will decrease in size by 12 percent and will shift northward by 700 km during this century. In the contiguous U.S., researchers expect that lynx in mountainous habitat will, to some extent, track climate changes by using higher elevations on mountain slopes, assuming that vegetation communities supportive of lynx and hare habitats also move upslope (Gonzalez *et al.* 2007, p. 7). Some areas of the DPS (e.g., Maine, Minnesota) lack potential elevational refugia and, therefore, lynx populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102).

Lynx and hare habitats—boreal spruce-fir and subalpine forests—and, therefore, lynx distribution, are likely to shift upward in elevation within its currently occupied range and recede northward as temperatures increase (Gonzalez *et al.* 2007, pp. 7, 13–14, 19; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, pp. 26–27, 30–31; Vashon *et al.* 2012, pp. 60, 64; ILBT 2013, p. 69). Lienard *et al.* (2016, p. 7) conclude that spruce-fir forest types in New England, the Northern Great Plains, and higher elevations in the Rockies are vulnerable to drought-related stress from climate change during the next century. The boreal spruce-fir forests that provide habitat for lynx and snowshoe hares are thought to be limited by higher summer temperatures and drought (Iverson and Prasad 2001, pp.192–196) and, under a suite of emissions and climate change scenarios, are projected to diminish dramatically or disappear from much of the eastern U.S. (Iverson and Prasad 2001, p. 196; Iverson *et al.* 2008, pp. 390–400). Within the last 20 to 25 years, widespread mortality and reduced growth in red spruce in the Northeast are believed to be linked to climate stress (McLaughlin *et al.* 1987, p. 501, Johnson *et al.* 1988, p. 5373.). Climate modeling suggests that lynx habitat and populations are anticipated to decline accordingly (Carroll 2007, pp. 1098–1102) and may disappear completely from parts of the range of the DPS by the end of this century (Johnston *et al.* 2012, pp. 6–13). Remaining lynx populations would likely be smaller than at present and, because of small population size and increased isolation, populations would likely be more vulnerable to stochastic environmental and demographic events (Carroll 2007, pp. 1100–1103).

Climate change is disproportionately affecting the boreal forest in Canada, the source of lynx dispersing into the DPS. Arctic and alpine ecosystems are among the most sensitive to climate warming (Diaz and Eischeid 2007, entire). Boreal forests have been identified as a critical "tipping element" of the Earth's climate system and are believed to be more sensitive to drought than other forests (Lenton *et al.* 2008, pp. 1788, 1791). Studies suggest a threshold for boreal

forest dieback of ~ 3 °C global warming (Lucht *et al.* 2006, entire, Joos *et al.* 2001, entire). Global temperatures are increasing and snowfall is declining at the fastest rate in higher latitudes within the boreal forest region of Canada and Eurasia (IPCC 2007). Predicted changes to the boreal forest are already occurring, and much of the climate-induced change is occurring faster than originally predicted, suggesting rapid change as opposed to slow linear change (Soja *et al.* 2007, pp. 5-6). General circulation models are in agreement that winter warming across the circumboreal region will be in excess of 40 percent above the global mean (Soja *et al.* 2007, p. 4). Increases in precipitation are expected in the boreal region of Canada, particularly during the winter, but may be offset with increases in summer drought, heat stress and evapotranspiration (Stocks *et al.* 1998, entire). Thus, boreal forests are experiencing increases in tree mortality (Peng *et al.* 2011, entire). Several authors have suggested that grasslands, aspen parklands, and temperate forest will expand northward resulting in decreases in boreal forest (Rizzo and Wiken 1992, p. 50; Starfield and Chapin 1996, entire; Rupp *et al.* 2000, entire), which could further fragment spruce-fir habitat (Iverson *et al.* 2008, p. 404; Tang and Beckage 2010, pp. 152-156; Simons-Legaard *et al.* 2016, p. 5; Rustad *et al.* 2012, p. 15). Climate change is expected to further fragment boreal forest in southern Canada (Hogg 1994, entire) and would reduce habitat connectivity between lynx populations in the contiguous U. S. and southern Canada.

Changes in the Frequency and Pattern of Disturbance Events – The distribution, amount, and composition of lynx habitat could be rapidly and dramatically altered by an increasing occurrence and persistence of drought, along with associated outbreaks of insects and pathogens, wind and ice storms, and wildfires (ILBT 2013, p. 70). All of these factors are potentially interrelated with multiple feedback mechanisms, and some have a cascading effect (Dale *et al.* 2001, p. 729). For example, drought can weaken trees, increasing their vulnerability to insects and pathogens. Insects and pathogens can create dead trees or increase fuel loads, potentially increasing the risk and intensity of fire. The boreal forest is a complex and variable system, and these effects are expected to vary in time and space. Climate change may compound these complex interactions into new domains that may be unprecedented and unpredicted (Dale *et al.* 2001, p. 729). These interactions may appear slowly and be difficult to detect because trees live for so long or they be manifested quickly after a catastrophic perturbation to the forest.

Climate change-induced drought and heat stress have already affected temperate and boreal forest (Allen *et al.* 2010, entire), particularly in the West, where tree mortality rates have increased rapidly in recent decades (van Mantgem *et al.* 2009, entire). Droughts occur irregularly in forests in eastern North America and the Pacific Northwest, annually at the end of the growing season in forests at the midcontinental prairie–forest border, and annually in summer in western interior dry forests that depend on winter precipitation (Dale *et al.* 2001, p. 727). Increase in growing-season temperature could increase evaporative demand, triggering moisture stress. Under several climate scenarios, future increases in drought stress are expected in the Southern Rockies and parts of the Northwest (Dale *et al.* 2001, p. 727). The Great Lakes region and parts of the Northwest could experience drought stress within two

decades, even though these regions may become wetter in later decades (Dale *et al.* 2001, p. 727).

The frequency of wildfire is increasing in boreal forests of North America. Extended fire seasons and increases in the total area burned are anticipated in the western U.S. with continued climate warming (McKenzie *et al.* 2004). Evaluating wildfire patterns in the western U.S. from 1970-2004, Westerling *et al.* (2006, entire) found rapid and dramatic increases in the frequency of large fires, wildfire durations, and the length of the wildfire season beginning in the mid-1980s. Mesic, middle- and high-elevation forest types (such as lodgepole pine and spruce-fir) in the northern Rocky Mountains experienced the greatest increases. Increased spring and summer temperatures and an earlier spring snowmelt strongly influenced large wildfires, suggesting that climate is the primary driver of these changes rather than fire exclusion (suppression), which appears to have had little impact on natural fire regimes of these higher-elevation forest types in this area (ILBT 2013, p. 70). In contrast, climate change is increasing precipitation in boreal forest regions of eastern North America, which has reduced wildfire frequency (Bergeron *et al.* 2001, p. 388). Under multiple climate scenarios, large increases in fire frequency are expected for boreal forest in central and western Canada, and reduced frequency in eastern Canada - a situation that reflects past Paleoclimates that were warmer than the present (Flannigan *et al.* 2001, pp. 860-862). Increased fire frequency at the grassland – aspen parkland – boreal forest transition in western Canada may hasten the conversion of boreal forest to aspen parkland and aspen parkland to grassland (Flannigan *et al.* 2001, p. 860-861), which could affect connectivity and gene flow in lynx populations.

Warmer springs could increase the frequency and duration of wildfires, which in turn could increase vulnerability of surviving trees to bark beetle attack (Westerling *et al.* 2006; ILBT 2013, p. 70). Increasing temperatures and forest homogeneity could create conditions favorable for bark beetle outbreaks that exceed natural disturbance thresholds, perhaps increasing the likelihood of additional outbreaks in the resulting large areas of even-aged forests (Raffa *et al.* 2008; ILBT 2013, p. 70).

Climate change is dramatically affecting the frequency and intensity of some eruptive boreal forest insect pests and pathogens that affect disturbance patterns in spruce-fir forests. Changes in temperature and precipitation affect herbivore and pathogen survival, reproduction, dispersal, and distribution. For example, native bark beetles, such as the spruce beetle (*Dendroctonus rufipennis*) and mountain pine beetle (*Dendroctonus ponderosae*), are key agents of change in coniferous forest ecosystems in western North America and have recently defoliated millions of hectares – among the largest and most severe in recorded history (Bentz *et al.* 2009). Drought-stressed conifers have increased vulnerability to insect attack. By the end of the century, changes in temperatures across the boreal forests of western North America may cause markedly high probability of outbreak of these species (Bentz *et al.* 2010. pp. 607, 609). In contrast, the range of the spruce budworm, a major pest of spruce-fir ecosystems in eastern North America, is expected to shift northward reducing vulnerability of spruce-fir forests in Maine and Minnesota (Regniere *et al.* 2010, entire). Widespread clearcutting following the most recent

spruce budworm outbreak in Maine was the primary driver creating the current broad distribution of high-quality lynx habitat (Hoving *et al.* 2005; Vashon *et al.* 2012).

Introduced species can affect forests through herbivory, predation, habitat change, competition, alteration of gene pools via hybridization with natives, and disease (as either pathogens or vectors) and can alter the diversity, nutrient cycles, forest succession, and fire frequency and intensity of some ecosystems (Dale *et al.* 2001, p. 727). Climate change will modify the distributions of many introduced species. Currently, there are few exotic species in North American boreal forests. This is likely because remote areas with little human intervention receive fewer exotic species. However, exotic species could be introduced in the future as boreal systems are increasingly exploited for forest products, mining, energy production, and other natural resources (Schinder and Lee 2010, entire).

Ice storms occur throughout the northern U.S.but are most frequent in the Northeast (Dale *et al.* 2001, p. 728). For example, in January, 1998 a severe ice storm extensively damaged the canopy of many northeastern U.S. and eastern Canadian forests, causing moderate to severe forest damage to over 10 million acres in the Northeast U.S. and southern Quebec (Jones and Mulhern 1998, p. 19; Irland 2000, entire; Millward and Kraft 2004, entire). Ice storm damage to stands can range from light and patchy to total breakage of all mature stems over extensive areas (Irland 2000, entire). It is uncertain how climate change will affect the frequency, intensity, location, and extent of ice storms; however, atmospheric warming will most likely shift the locations of prevailing ice storms northward.

Introduction of Lynx or Hare Disease and Parasites - Climate change can increase pathogen development and survival rates, disease transmission, and host susceptibility, and some species are predicted to experience more frequent or severe disease impacts with warming while others may be relieved of pathogens (Harvell *et al.* 2002, entire, Harvell *et al.* 2009, entire). Climate change is likely to cause major changes to the geographic range and incidence of insect and tick-borne diseases (Daszak *et al.* 2000).

No apparent climate-influenced parasites or diseases have been identified that would affect Canada lynx or snowshoe hares, but lynx experts believed this is difficult to predict and remains a possibility (Lynx SSA Team 2016, pp. 27, 37-39). A few pathogens have been documented in lynx in the DPS. For example, plague, a flea-borne disease caused by the bacterium *Yersinia pestis*, which is not native to North America, was reported for the first time in lynx in Colorado (Wild *et al.* 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 lynx released in Colorado between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to *Y. pestis*; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado. Exposure of some lynx to feline parvovirus was detected in six areas in western North America (Montana-Alaska; Biek *et al.* 2002). *Troglostongylus wilsoni* is a nematode that infects the lungs of lynx and bobcats (Sarmiento 1956; Van Zyll de Jong 1966; Kumar 1974; and Reichard 2004) and was detected in Maine lynx (Vashon *et al.* 2012, p. 24). Lynx with heavy infestations have difficulty breathing and succumb to starvation, as occurred with several Maine lynx (Vashon *et al.* 2012, p. 24).

Reduction in Gene Flow - Koen *et al.* (2014a, entire) hypothesized that climate change would create increasingly unsuitable environmental conditions for lynx (e.g., milder winters with reduced snow quality, declining and fragmented boreal forest), which was associated with low genetic diversity and high genetic differentiation at the trailing (southern) edge of the range. Furthermore, high winter temperature, low snow depth, and low proportion of suitable habitat were strongly correlated with neutral genetic diversity, low allelic richness, and high genetic differentiation (Koen *et al.* 2014a, p. 757). The authors surmised that genetic structuring in southern lynx populations could be caused by a northward shift in optimal conditions, resulting in isolation and extirpation of lynx populations at the trailing edge of their range or climate-induced changes in the distributions of snowshoe hare or bobcats causing lynx to shift northward. Lynx with the greatest allelic richness were found in areas with the deepest snow in the core of their range in northern Ontario (Koen *et al.* 2014a, p. 758). The authors concluded that climate warming has reduced gene flow at the receding (southern) edge of the lynx's range, and that southward gene flow from Canada into threatened U.S. populations is unlikely (Koen *et al.* 2014a, p. 760). Stenseth *et al.* (2004, entire) documented population and genetic structuring in the lynx populations east and west of Hudson Bay based on differences in snow conditions on either side of this divide. This may be explained by the reluctance of lynx to disperse between areas having different snow regimes and snow quality. Snow conditions may be the key factor in the spatial, ecological, and genetic structuring of Canada lynx (Stenseth *et al.* 2014, pp. 10633-10644).

Climate warming may further isolate lynx populations, thus reducing gene flow, by reducing connectivity between populations. For example, gene flow between eastern Canada and Maine lynx populations depends on an ice bridge for dispersal across the St. Lawrence River. Although some lynx currently cross the river, Koen *et al.* (2014a, entire) found genetic structuring on either side of the river. Thus, the river already restricts gene flow. Climate-induced deteriorating ice conditions on the St. Lawrence River could further restrict gene flow between lynx populations north and south of the river (Koen *et al.* 2015, p. 528). Between 1969 and 2002 there was a 20 to 40 percent reduction in sea-ice cover during the spring thaw in the Gulf of the St. Lawrence (Johnston *et al.* 2005). Conversely, reduced ice on the St. Lawrence may prevent bobcats from dispersing northward into lynx areas in central Quebec (Koen *et al.* 2015, p. 528).

3.3 Vegetation Management

Forest management occurs across the range of the lynx and can directly affect important habitats and prey. At the time of listing, management activities uninformed by consideration of negative impacts to the species were identified as being of greatest potential concern to lynx conservation (68 FR 40076-40101). Forest management is the most prevalent land use throughout the lynx DPS and can have beneficial, neutral, or adverse effects on lynx and snowshoe hare habitat and populations (65 FR 16071; 68 FR 40083; ILBT 2013, p. 71). Forest management affects stand structure, composition, and arrangement on the landscape, which are important elements of habitat for snowshoe hares and lynx. At the home range scale, lynx throughout the DPS select landscapes having the greatest snowshoe hare densities. In Maine

and Minnesota these are young, regenerating spruce-fir forests (Hoving *et al.* 2004; McCann and Moen 2011) and in the West regenerating lodgepole pine (Koehler, Maletzke, Berg *et al.* 2012) and dense mature conifer forest, as well as young stands with dense spruce-fir saplings (Griffin 2004, Squires *et al.* 2010, pp. 1648, 1653–1656; Berg *et al.* 2012). Silvicultural prescriptions and cutting practices in boreal forest types vary widely throughout the lynx DPS depending on the landowner, forest ecology and ecoregion, tree species, site conditions (e.g. moisture, slope, aspect), disturbance regimes (e.g., fire, insect outbreaks), forest policy and regulations, logging equipment, and markets for forest products. Forest management that creates habitat for hares and lynx in one geographic area may not be beneficial to hares and lynx in another.

Nevertheless, snowshoe hares throughout the DPS range respond to one common denominator. Dense understory (horizontal cover) is the most important forest structural characteristics for hares throughout their range (Ferron and Ouellet 1992; Wolfe *et al.* 1982; Litvaitis *et al.* 1985). Dense, horizontal cover provides hares with a source of browse and cover from predation. Softwood (e.g., spruce-fir) has about three times more cover value than hardwoods (Litvaitis *et al.* 1985). Thus, stem density (or stem cover units) and snowshoe hare density are directly and positively correlated (Conroy *et al.* 1979; Sullivan and Sullivan 1988; Koehler 1990b; Koehler and Brittell 1990; Thomas *et al.* 1997; Hodges 2000a; Mowat *et al.* 2000; Homyack *et al.* 2006; Robinson 2006; Scott 2009; Fuller and Harrison 2013). Forest practices that promote high stem density and dense horizontal cover can increase snowshoe hare densities (Keith and Surrendi 1971; Fox 1978; Conroy *et al.* 1979; Wolff 1980; Parker *et al.* 1983; Livaitis *et al.* 1985; Bailey *et al.* 1986; Monthey 1986; Koehler 1990a, b; Robinson 2006; Fuller *et al.* 2007; Homyack *et al.* 2007; Scott 2009; McCann and Moen 2011). Forest practices that reduce dense understory generally reduce habitat quality for hares and lynx.

Effects of forest practices on snowshoe hare habitats have been studied across the range of the species (Conroy *et al.* 1979; Sullivan and Sullivan 1988; Koehler 1990b; Thomas *et al.* 1997; Homyack *et al.* 2005; Robinson 2006; Griffin and Mills 2007; Scott 2009; Berg 2010; Ivan 2011a; Lewis *et al.* 2011; McCann and Moen 2011). Similarly, the effects of forest management on lynx habitat use, movements, and home range have been investigated by Koehler (1990a), Koehler and Brittell (1990), Fuller *et al.* (2007), Homyack *et al.* (2007), Moen *et al.* (2008), Vashon *et al.* (2008b), Simons (2009), Squires *et al.* (2010), Simons-Legaard *et al.* (2013), Simons-Legaard *et al.* (2016).

Historically, the dominant natural disturbance processes that created young, regenerating conifer forest conducive to hares and lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990; Heinselman 1996; Veblen *et al.* 1998; Agee 2000; Seymour *et al.* 2002; Lorimer and White 2003). In forests of northern Maine, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S. After disturbances, forests generally develop through several stages described by Oliver (1980) as “stand initiation,” “stem exclusion,” “understory reinitiation,” and “old growth.” Stand dynamics, particularly within-stand competition for light, nutrients, and space, determine how forests grow

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and respond to intentional manipulations and natural disturbances (Oliver and Larson 1996). The frequency and severity of disturbances have a large role in determining which species will dominate in a stand after the disturbance event. Snowshoe hare and lynx habitat are created during the stand initiation stage, after the young trees have established and grown tall enough (1-3 meters [m]) to protrude above the snow and provide adequate horizontal cover. During the stem exclusion stage (~10 m depending on tree species) the tree crowns lift and lower branches self-prune, thus reducing the live horizontal branches providing food and cover for snowshoe hares. In the old growth stage, understory may re-develop (e.g., in forest gaps where mature trees die or fall down) and food and cover may again become available to support snowshoe hares.

Commercial timber management of conifer forests traditionally has been designed to: in very young, regenerating forest to select for desired species (e.g., herbiciding, plantations) and reduce tree density to promote tree growth (e.g., precommercial thinning); in young middle-aged forest to improve growth and vigor of mature trees (e.g., commercial thinning, pruning, thinning from below); and in mature forest to reduce the vulnerability of commercially valuable trees to insects, disease, and fire (e.g., commercial thinning, group selection, fuels reduction). The culmination of the process (or a forest rotation) is harvesting of forest products. Just as the timing and intensity of a natural disturbance affects the composition of the succeeding forest, the season, climate, machinery, and type of final harvest (e.g., clearcut v. partial harvest) have a large role in determining the species composition and health of the next crop of trees. Timber management practices may mimic natural disturbance processes but often are not an exact ecological substitute. Some practices, such as use of herbicides to suppress hardwood regeneration or plantations do not have an historical analogue. Timber harvest may differ from natural disturbances by:

- Removing most standing biomass from the site, especially larger size classes of trees, and down logs, which alters microsite conditions and nutrient cycling;
- Creating smaller, more dispersed patches and concentrating harvest at lower elevations in mountainous regions and on more nutrient rich soils, resulting in habitat fragmentation;
- Causing soil disturbance and compaction by heavy equipment, which may result in increased water runoff and slower tree growth at the site; or
- Giving a competitive advantage to commercially-valuable tree species and reducing the structural complexity of the forest through the application of harvest, planting, thinning, and herbicide treatments.
- Forest practices often have a smaller footprint on the landscape than widespread fire, insect, or wind damage.

Forest management may (or may not) be compatible with creating or maintaining habitats capable of supporting hares and lynx. Where the objective is to provide snowshoe hare habitat by creating additional early-successional forest conditions, management considerations include selecting areas that are capable of, but not currently providing, dense horizontal cover, designing the appropriate size and shape of treatment units, retaining coarse woody debris, and

maintaining high stem densities in regenerated forests (Koehler and Brittell 1990; Homyack *et al.* 2004; Bull *et al.* 2005; Fuller and Harrison 2005; Ivan 2011a).

North America is the world's leading producer and consumer of wood products. Therefore, worldwide trends in forest products markets greatly affect forest management outcomes and thus, the amount and quality of lynx habitat in the DPS. Forest management decisions (e.g., to focus on hardwood or softwood production) can change dramatically in response to unpredictable and changing forest products markets. Globalization of manufacturing and expanded use of electronic media have reduced demand in pulp and paper since the late 1990s, and the collapse of housing construction since 2006 have contributed to declines in U. S. wood product output. Within the northern region of the U. S. (Maine to North Dakota) there has been a considerable decline in terms of employment, mill numbers, wood consumption and forest harvests since 2000 (Woodall *et al.* 2011). As a large amount of this region's forest industry is print paper manufacturing and composite panel production, the rise of electronic media and decline of home construction has precipitated a decade of decline, which only deepened since the recession of 2007-2009. The West, prior to the recession, was a major softwood lumber producing region, and was particularly hard hit by the recession and housing collapse. Employment dropped by 30 percent or nearly 80,000 workers and annual value of output fell by more than 25 percent (Keegan *et al.* 2011). Under depressed markets, landowners may reduce harvests, which may be to the detriment of lynx in some parts of the DPS (e.g., Maine and Minnesota), and to the benefit of lynx in others (the West).

Markets for softwood products are particularly volatile and depend on demand for paper and housing. Thus, softwood management is affected by economic factors that are difficult to predict. In recent years, the forest products industry throughout the U. S. experienced a downturn in output levels not seen in decades, and employment losses in the hundreds of thousands (Woodall *et al.* 2011, p. 595). Despite depressed markets, one area of increasing interest is bioenergy production. Rising energy costs and growing concerns over global climate change have increased interest in bioenergy production, and the U. S. Energy Independence and Security Act (2007) mandates a five-fold increase in biofuel production (Benjamin *et al.* 2009, p. 125). The wood pellet sector is expected to grow, although woody biomass is typically the lowest value wood commodity sold from the forest. Thus, it is questionable whether wood energy revenues would be enough to sustain forest investments and forest management into the future (Woodall *et al.* 2011, p. 601).

Whereas management of State and Federal forest lands have been relatively stable in recent decades, management and ownership of private forest land ownership has been extremely unstable. This has resulted in major shifts in forest management strategies, outcomes, and products. For example, in the last two decades in Maine, where nearly all the lynx critical habitat is on private land, about 23.8 million acres (80 percent) of industrial land ownerships in the "northern forest" (Adirondacks to northern Maine) were sold to many different kinds of financial groups (Hagan *et al.* 2005). These groups have short-term investment goals and different management objectives and have dramatically changed harvest practices. Whereas the previous large industrial landowners focused on the forest land base as a supply for their

manufacturing facilities, the new Timber Investment Management Organizations (TIMOs) and Real Estate Investment Trusts (REITs) focus on maximizing return on their investment (Jin and Sader 2006, p. 178). Initially, the effects of ownership changes were uncertain (McWilliams *et al.* 2005), but an evaluation of harvesting in the last decade indicates these landowners increased harvest rates, shortened rotation rates, and shifted to managing and harvesting hardwood tree species (Jin and Sader 2006, p. 183-185). On one hand, these trends in Maine private lands management make lynx management commitments more difficult because short-term landowners are not interested in long-term commitments. On the other hand, some easement owners may have an incentive to manage for lynx to meet forest certification requirements.

The extensive sale of private forestlands initiated the growth of conservation easements in this region (deGooyer and Capen 2004; Lilieholm *et al.* 2010). Conservation land as a percentage of Maine's State area increased from less than 5 percent in 1987 to approximately 19 percent by 2012 (Beck *et al.* 2012, p. 15). Conservation easements restrict development but usually do not affect forest management; neither do they typically require management for lynx and other rare species. Some private forestlands were sold to State and Federal agencies and conservation interests. For example, in recent years The Nature Conservancy purchased 310,000 acres of private forestland in Montana and 185,000 acres of private forestland in northern Maine. Lands in conservation ownership have a high probability of being managed to benefit hares and lynx.

Finally, future trends in forest management will be affected by climate change (Irland *et al.* 2003, entire). Many models have been developed to project how U.S. timber production and markets may adapt to climate change (e.g. Burton *et al.* 1998, Joyce *et al.* 1995, Perez-Garcia *et al.* 1997, Sohngen and Mendelsohn 1998). Economic models predict that under climate change, total U.S. timber inventories will increase, timber harvest will increase, and product prices will decrease relative to an assumed stable climate. Some models predict that consumers will gain from climate change while landowners in some regions will lose. The forest industry will adapt to climate change in many ways including using alternate tree species in manufacturing, shifts to geographic regions of the country with economic advantages in timber growth, and increasing forest plantations with new species that are favorably adapted to the new climate and markets. Many strategies have been evaluated to increase the quantity of carbon stored in North American forests (Irland *et al.* 2003) including discontinuing or greatly reducing harvest in some forests to build carbon reserves, increased recycling to reduce use of forest products, converting agricultural lands to forests, and substituting wood products for more energy-intensive products. Increased atmospheric carbon will increase forest growth slightly, except for softwood (Irland *et al.* 2001, p. 757-758). Sawtimber production, which sequesters more carbon, is expected to increase (Irland *et al.* 2001, p. 758). Expanding landscapes with older growth conifer forest to sequester carbon could benefit lynx in the West and be to the detriment of lynx in the East.

Climate change will affect forest-related recreation. Warmer lowland temperatures will attract more people to relatively cooler mountainous and northern forests (Irland *et al.* 2001, p. 759). The ski industry is currently in decline, and climate-induced changes in snowfall will further

stress this industry, except for higher elevation western resorts where snowfall is more dependable and where artificial snow is less expensive to make (Irland *et al.* 2001). These climate-induced trends in recreation are anticipated to bring more people into the lynx DPS, which could bring additional social pressures concerning decisions related to forest management (e.g. clearcutting; Swanson and Loomis 1996). At this time, there are many uncertainties concerning the socioeconomic implications of climate change and adaptation in the northern forests supporting the lynx DPS.

Past and future forest management affects many of the requirements necessary for the continued existence of lynx in the DPS. Forest management is expected to be the predominant land use throughout the DPS into the foreseeable future, and major climate-induced changes in forest industry are anticipated (Irland *et al.* 2001, entire). Beneficial effects of forest management include 1) creating lynx habitat, 2) maintaining an undeveloped landscape conducive to lynx, and 3) long term management planning for lynx (especially on Federal lands). Adverse effects to lynx, hares, and their habitat that are occurring or can be reasonably be anticipated include 1) reduced quality of hare habitat in some parts of the DPS, 2) loss and fragmentation of lynx and hare habitat in the U. S., and 3) changes in the frequency and pattern of disturbance events. Synergetic effects between forest management and other stressors (e.g., climate change, trapping, development) may intensify their effects (Carroll 2007). Habitat loss and fragmentation are believed to currently be important stressors for lynx in the DPS, but it is possible that other pathways for forest management are, or may become, equally important. Hares and lynx will continue to be affected (both positively and negatively) by forest management into the foreseeable future. Forest management stressors primarily affect lynx by lowering landscape hare densities, which in turn reduces lynx reproduction and survival.

Reduced Quality of Hare Habitat - Throughout the lynx DPS, some vegetation management practices, especially thinning in young, dense regeneration, reducing overstory canopy in mature multi-story spruce-fir forests (in the West), and partial harvesting (in northern Maine) reduce the quality of boreal forest habitats for snowshoe hares and lynx. This could cause lynx to increase their home ranges, reduce productivity, or in extreme cases to abandon their home range or cause mortality.

Thinning of young, dense sapling stage conifers (precommercial thinning) is a forest management practice used widely throughout the DPS to increase the growth and value of selected trees and to reduce the time to maturity of a stand of trees. Precommercial thinning removes competing trees of the same species or shrubs and trees of other species (Daniel *et al.* 1979; Homyack *et al.* 2005, 2007). Reducing the density of sapling-sized conifers in young regenerating forests to increase the growth of certain selected trees promotes more homogeneous patches and reduces the amount and density of horizontal cover, which is needed to sustain snowshoe hares (Sullivan and Sullivan 1988, Hodges 2000b, Griffin and Mills 2004, Ausband and Baty 2005, Griffin and Mills 2007, Homyack *et al.* 2007, Ellsworth 2009). Hares reach highest densities in stands with stem densities ranging from 4,600–33,210 stems/ha (1,862–13,445 stems/ac)(Wolff 1980, Parker 1984, Litvaitis *et al.* 1985, Monthey 1986, Parker 1986, Koehler 1990a, Griffin 2004, Fuller and Harrison 2005, Robinson 2006, Scott

2009), whereas thinned stands have densities of 2990 (6-foot spacing) to 1,682 (8-foot spacing) stems/ha (Pitt and Lanteigne 2008, p. 593). Precommercial thinning has been shown to reduce hare numbers by as much as 2- and 3-fold (Griffin and Mills 2004, 2007; Homyack *et al.* 2007) because of reduced cover and decreased availability of browse. Griffin and Mills (2007) reported that, if their results were representative, the practice of precommercial thinning could significantly reduce snowshoe hares across the range of lynx.

There are anecdotal examples of precommercially thinned stands that subsequently "filled in" with understory trees. Some have suggested this could be a technique to extend the time that understory trees and low limbs provide the dense horizontal cover that constitutes snowshoe hare habitat. The duration between time of thinning and regrowth to a height providing winter snowshoe hare habitat would likely vary by tree species, each having different regenerative capacities that could be influenced by a variety of local factors (e.g., topographic relief, moisture, and mineral and organic content of the soil; Baumgartner *et al.* 1984, Koch 1996). Bull *et al.* (2005) reported that the slash and coarse woody debris remaining after precommercial thinning provided both forage and cover for snowshoe hares up to a year following treatment. However, Homyack *et al.* (2007) found that snowshoe hare densities were reduced following precommercial thinning for 1–11 years post-thinning. They further suggested that after precommercial thinning, the stands did not regain the structural complexity in the understory that would be needed to support pre-treatment snowshoe hare densities. At this time, no other data are available to quantify the re-establishment of snowshoe hare habitat and over what time period, or the response by snowshoe hares, as compared with sites that were not precommercially thinned, so this remains an unproven management technique. As an alternative to standard precommercial thinning (i.e., complete thinning resulting in a homogeneous patch), Griffin and Mills (2007) suggested retaining at least 20 percent of the patch in untreated clumps of about ¼ ha (½ ac), which would maintain hare habitat in the short term. However, Lewis *et al.* (2011) found that landscapes with patches of high-quality habitat surrounded by similar vegetation supported more hares than did more fragmented landscapes composed of high-quality patches in a matrix of poorer-quality habitat. Further long-term studies of modified thinning methods are needed.

Because of documented adverse effects of precommercial thinning to snowshoe hares and lynx, in 2007 and 2008 the USFS amended Forest Plans to incorporate management that would conserve lynx, including direction that prohibited precommercial thinning in most lynx foraging habitat (USFS 2007, pp. 8, 11-14, 36; USFS 2008, pp. 6-9, 23-26). However, precommercial thinning is not regulated on private forest lands throughout the remainder of the DPS.

Uneven-aged management (single tree, partial harvest, and small group selection) practices can be employed in stands where there is a poorly developed understory, but have the potential to produce dense horizontal cover for snowshoe hares. Removal of select large trees can create openings in the canopy that mimic gap dynamics and help to maintain and encourage multistory attributes within the stand. However, if removal of large trees opens the canopy to the extent that the patch functions as an opening, this may discourage use by lynx (Koehler 1990a, von Kienast 2003, Maletzke 2004, Squires *et al.* 2010). Removal of larger trees from mature multi-

story forest stands to reduce competition and increase tree growth or resistance to forest insects may reduce the horizontal cover (e.g., boughs on snow), thus degrading the quality of winter habitat for lynx (Robinson 2006, Koehler *et al.* 2008, Squires *et al.* 2010). Similarly, removing understory trees from mature multi-story forest stands reduces the dense horizontal cover selected by snowshoe hares, and thus reduces winter habitat.

Partial harvesting broadly describes many methods of removing a portion of the overstory trees from a forest stand. Partial harvesting includes selective cuts, shelterwood cuts, and uneven-aged management. Partial harvest may be "light" (e.g., <10 percent of trees removed) to "heavy" (e.g., 90 percent of trees removed). Since passage of the Maine Forest Practices Act in 1989, various forms of partial harvesting have replaced clearcutting as the predominant form of forest management in northern Maine (Sader *et al.* 2003, entire). In recent years, about 425,000 acres of Maine forest are harvested annually and 96 percent of this land is partially harvested (Maine Forest Service 2016). After 17 years of extensive partial harvests, much of the northern Maine landscape has been influenced by this form of forestry, and will continue to be into the future. The popularity of this form of harvesting extends beyond Maine. From the mid-1980s to mid-1990s, partial harvesting comprised 62 percent of the harvest in the U. S., and clearcuts comprised the other 38 percent. Partially harvested stands result in a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006). On average, partially harvested stands supported about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006). Shelterwood cuts, a form of even-aged management, are the exception and have maintained densities similar to regenerating clearcut stands (D. Harrison, U. Maine, unpubl. data). Current hare densities in partially harvested stands in Maine average about 0.4 hares/ha (Simons 2009), which is below the landscape hare densities (0.5 hares/ha (Ruggiero *et al.* 2000b, Simons-Legaard *et al.* 2013) needed to support lynx.

In the Great Lakes Geographic Unit, prescribed burning is used in lynx habitat primarily as a tool to reduce fuels (including from blow-down) and mimic a more natural fire regime in pine forest types. In these instances there is a short-term (10–30 years) impact on snowshoe hare habitat. In the western U.S., prescribed fire for ecosystem restoration is most applicable to the dry ponderosa pine and Douglas-fir forests that are not lynx habitat. Because spruce-fir forests are generally composed of thinner-barked trees that are easily killed even with light fire, this technique is not used frequently in most lynx habitat.

Biomass removal for energy production targets the removal of dead trees, logging slash, and small-diameter trees and shrubs. Biomass removal is similar to fuels treatments in reducing cover and habitat for snowshoe hares.

Fuels treatments commonly are designed to remove understory biomass and reduce stem density in forests that are outside their historical range of variability, and to clear fuels adjacent to human developments for safety or to protect investments. These types of projects are becoming more common. In the western U.S., projects designed to restore forests to a condition more representative of the historical range of variability are generally targeted to drier, lower-

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elevation forests affected by fire suppression (Hessburg *et al.* 2005), which are not lynx habitat. Lynx habitats in higher-elevation spruce-fir forests have been less affected by past fire suppression and are mostly within the historical range of variability (Agee 2000). Fuels treatments may be needed to protect human communities and capital improvements by reducing the intensity and rate of spread of a fire, affording control actions with a higher probability of success and providing safer conditions for firefighters. By removing or reducing the understory and ladder fuels to meet those objectives, dense horizontal cover important to snowshoe hares is reduced and habitat value is diminished for hares and lynx.

Loss, Degradation and Fragmentation of Boreal Forest Habitat - Forest management rarely results in conversion of lands to non-forest. In fact, forested landscapes have increased in some parts of the DPS (especially in the Northeast) because of farm abandonment and recolonization by second-growth forest. However, some forms of forest management such as selective harvesting and fire suppression can intentionally (or not) alter tree species composition away from boreal forest types that support snowshoe hare and lynx. Similarly, lack of forest management can alter tree species composition (Trani *et al.* 2001, pp. 415-417). Other stressors, such as insects and climate change, can work in synergy with forest management to reduce boreal forest. For example, in northern New England clearcutting sometimes leads to drying of the forest floor and consequent heavy mortality in spruce and fir regeneration and increased light levels that increase hardwood competition (White and Cogbill *in* Eagar and Adams 2012, p. 32).

Plantations can convert native forest communities into monocultures of a native or exotic tree species that may lack hardwood browse for snowshoe hare. Cutting rotation can be reduced by half through mechanical site preparation, planting, and suppression of hardwood competition. Conifer stem densities in plantations range from 800-5,000 stems/ha and may support relatively low populations of snowshoe hares because of the initial wide spacing of trees (Bellefeuille *et al.* 2001, p. 44). Hare densities may increase after trees in a plantation reach the sapling stage and branches intermingle at the ground level creating horizontal cover if the lateral branches are not pruned (Parker 1984, p. 163; Parker 1986 p. 160; Roy *et al.* 2010, p. 285). However, the period of time that spruce plantations may support high hare densities in Maine and eastern Canada may be relatively short (10 to 17 years post-harvest) compared to regenerating softwood clearcuts (15-35 years post-harvest; Simons-Legaard *et al.* 2013, p. 569).

Under certain forest stand conditions, herbicide treatment may have long-term effects on stand composition and structure (MacLean and Morgan 1983, Daggett 2003), thus potentially reducing food, cover, and habitat for hares (Borrecco 1976, Bellefeuille *et al.* 2001, p. 43, Thompson *et al.* 2003 p. 462). Understory deciduous stems were lacking in stands treated with herbicide (Homyack *et al.* 2004). Although herbicide treatments reportedly do not directly affect survival, fecundity, or other demographic parameters of snowshoe hares (Sullivan 1996), treatments have indirect effects on hares via changes in vegetative cover and browse (Homyack *et al.* 2005, p. 10). In Norway, hares use of plantations was reduced up to 10 years after herbicide application (Hjeljord *et al.* 1988).

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Fragmentation - Lynx achieve highest densities in >100 km^2 landscapes having a high percentage of large, contiguous patches of high quality hare habitat (Simons 2009, Simons-Legaard *et al.* 2013). In Maine and northern Washington, landscapes where boreal forest habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Within their home ranges, lynx strongly select for habitat patches that enhance their foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges, by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that landscapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Forest management can fragment and isolate patches of high quality hare habitat (Simons-Legaard *et al.* 2016). In an intensively managed landscape, lynx habitat is described as a shifting mosaic of patches of habitat suitable to support the needs of resident lynx. Fragmentation of the naturally patchy pattern of lynx habitat in the contiguous U.S. can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation from forest management can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. For example, in Maine the proliferation of partial harvesting will actually increase the patches of high quality hare habitat by 57 percent, but the average size of patches will be diminished by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6).

Changes in Frequency and Pattern of Disturbance Events - Prior to European settlement, the dominant natural disturbance processes that created early-successional stages within the range of the lynx were wind events, fire, and insect and disease outbreaks (Kilgore and Heinselman 1990, Heinselman 1996, Veblen *et al.* 1998, Agee 2000, Seymour *et al.* 2002, Lorimer and White 2003). In forests of the Northern Maine Unit, wind, fire, insects, and diseases were predominant natural disturbance agents, while fire, insects, and diseases were predominant in the Great Lakes Geographic Unit and across the western U.S.

Today, forest management is the predominant form of disturbance in boreal forest types throughout the DPS, but in the West insect outbreak or wildfire are also critical agents of disturbance that influence and interact with forest management. Throughout the DPS, the frequency of harvesting accelerates in response to salvaging insect damaged stands. In some instances, forest management has greatly altered the disturbance regime. For example, prior to logging, the Acadian forest in Maine and eastern Canada likely exhibited forest gap dynamics

similar to some parts of the West today, and true stand-replacing disturbances were quite uncommon with recurrence intervals of thousands of years. After several centuries of forest management, stand age structures in the Acadian forest have become simplified, and commercial timber rotations are a fraction (15 to 40 percent) of the lifespan of boreal tree species (Seymour 2002). Although the prevalence of these younger even-aged forest stands on the landscape may benefit hares and lynx in Maine, forestry has shifted the species composition of Maine's forest to tree species favored by frequent harvest disturbance, such as red-maple, paper birch, aspen, and balsam fir.

3.4 Wildland Fire Management

Wildfire is a natural and essential component of boreal and montane forests that plays an important role, along with forest insects and other disturbance factors, in creating and maintaining the shifting mosaic of stand ages and forest structure across large boreal landscapes that provide snowshoe hare and lynx habitats (Agee 2000, p. 47; Ruediger *et al.* 2000, pp. 1-3, 2-5, 7-6; ILBT 2013, p. 75). Wildfire creates and maintains lynx habitats by providing periodic vegetation disturbances that result in the spatial and temporal distribution of early-successional forest stands or patches within older stands featuring dense horizontal cover at ground and snow level. These stands/patches provide high-quality hare foraging habitat and typically support high hare densities, which in turn provide high-quality lynx foraging habitat. They are generated by (1) high-intensity, stand-replacing fires that result initially in removal of all or most vegetation, followed by regeneration of dense horizontal cover, or (2) low- or moderate-intensity fires that stimulate understory development in older stands without killing all the overstory, resulting in patches of dense horizontal cover within multi-storied stands (Agee 2000, p. 53; Ruediger *et al.* 2000, p. 7-6). These habitats become most favorable for hares and lynx when regenerating conifers grow tall enough to protrude above the snow, providing cover and food for hares throughout the winter (ILBT 2013, pp. 10-12). They remain important as winter foraging habitat, which may be the most limiting habitat for lynx (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 17, 27), until they reach the stem-exclusion structural stage and self-pruning results in the loss of dense horizontal cover above the snow, or until another disturbance resets them to the stand-initiation structural stage (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 1-3; ILBT 2013, p. 27). The length of time to achieve favorable hare and lynx habitat after fire (or other vegetation disturbance) and the duration for which those conditions persist vary across the lynx range depending on soil and vegetation potential, temperature and precipitation patterns, topography, fire intensity, and perhaps other local conditions (Agee 2000, pp. 62-71; Ruediger *et al.* 2000, p. 2-5; ILBT 2013, pp. 27-29, 75). Generally, regenerating forests in the DPS range may begin providing winter hare habitat within 10-20 years after fire or other disturbance, with favorable conditions persisting for 20-30 years after that (Koehler and Aubry 1994, pp. 86-87; Agee 2000, pp. 67-71; Fuller *et al.* 2007, p. 1985; McCann and Moen 2011, p. 515; Vashon *et al.* 2012, p. 15; ILBT 2013, pp. 28-29), although it may take longer, perhaps 35-40 years, for lynx habitat to recover in some parts of the range (e.g., Maletzke *in* Lynx SSA 2016, p. 21).

Fire frequency, size, intensity, and return intervals also vary across the range of the lynx and depend on localized vegetation communities, climatic conditions, and topography (Agee 2000,

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pp. 47-56; Ruediger *et al.* 2000, p. 4-8; ILBT 2013, pp. 75-76). In lynx habitats, fire intensity is typically high and fire return intervals long but variable, with large areas affected by infrequent stand-replacing fires and, in mixed fire regimes, moderate- or low-intensity fires in the intervals between stand-replacing events (Agee 2000, pp. 49-54; Ruediger *et al.* 2000, pp. 4-8, 7-6). Within the DPS range, fire return intervals in the Great Lakes Region appear similar to those in the core of the lynx's range in the Canadian and Alaskan taiga (roughly 50-150 years), with longer return intervals in Western (150-300 years) and Northeastern (up to 500 years) U.S. forests (Agee 2000, pp. 52-53; ILBT 2013, pp. 75-76). Despite these long intervals, fire is the dominant natural disturbance mechanism in lynx habitats in the DPS range except in the Northeast, where insects and wind are more important (Agee 2000, p. 53).

Current Federal wildland fire management policy recognizes fire as a natural ecological process essential to the health and resilience of some forest systems, and it attempts to balance the ecological, social, and legal aspects of wildfire (USDA and USDI 2009, p. 6). However, the prior history of fire response was largely one of active suppression for most of the last century (Zimmerman and Bunnell 2000, p. 288; USDI *et al.* 2001, p. 1-1; USDA and USDI 2003, p. 3; 68 FR 40092; Calkin *et al.* 2015, pp. 1-3) which, combined with other land-use practices, dramatically altered fire regimes in some places and created conditions prone to larger and more severe fires (USDI *et al.* 2001, p. 1-2). Because of (1) fire's important role in creating and maintaining high-quality early-successional hare habitat in most lynx habitats in the contiguous U.S., (2) the potential for fire suppression to alter this dynamic to the detriment of hares and lynx, and (3) the limited ability of land managers (at that time) to use fire to benefit hares and lynx, wildland fire management was identified as a "Lynx Risk Factor Affecting Lynx Productivity" (Ruediger *et al.* 2000, pp. 2-5, 5-2). To address these concerns, the authors developed objectives, standards, and guidelines for Federal land managers to restore fire's role in maintaining lynx habitats, attempt to mimic historical natural fire regimes, and integrate lynx habitat objectives into fire management plans (Ruediger *et al.* 2000, pp. 7-6 - 7-8). They also directed Federal land managers to evaluate whether fire suppression or other management practices had altered fire regimes and ecosystem function in potential lynx habitats and, where so, to use fire (naturally ignited fires or prescribed burns) as a tool to restore and maintain lynx habitat by creating or regenerating snowshoe hare habitat (Ruediger *et al.* 2000, p. 7-7).

In its 2000 listing rule and 2003 remanded determination, the Service recognized the potential for fire suppression to adversely affect lynx and hare habitats at local and regional scales, particularly in the Great Lakes Region, where fire suppression policies across land ownerships likely prevented fire from assuming its natural role in creating a landscape mosaic of vegetation communities and age classes (65 FR 16076; 68 FR 40095). In the Northeast, the Service concluded that the very long fire return intervals and maritime influence in lynx forest types indicated that fire did not historically play a significant role in creating or maintaining lynx and hare habitats and, thus, fire suppression was unlikely to have affected lynx habitat (68 FR 40094). In the West, the Service concluded that the effects of fire suppression were likely lower in lynx forest types because of their typically long fire return intervals compared to lower and drier forest types (65 FR 16074; 68 FR 40093-94). Overall, the Service concluded that fire suppression did not represent a threat to lynx in the Northeast and was a low-magnitude threat

in Great Lakes, S. Rockies, and N. Rockies/Cascades (65 FR 16075-16076; 68 FR 40093-40098).

In response to the guidance provided in the LCAS, the USFS, when developing the NRLMD and the SRLA to amend forest plans to address lynx conservation (see 3.1.1, above), evaluated whether fire suppression had adversely affected potential lynx habitats on national forests in the Northern and Southern Rockies. The USFS concluded that many forests in potential lynx habitat are in Condition Class 1, which means they have not missed a fire cycle because large, stand-replacing fire only occurs every 100 to 200 years; the long fire return interval has not been affected to any large degree by more recent fire suppression as is the case in drier forests with short fire return intervals; and they are close to historical conditions (USFS 2007, pp. 18, 20; USFS 2008, p. 11). In addition to the national forests covered by the NRLMD and SRLA (all national forests in the Northwestern Montana/Northeastern Idaho, GYA, and Western Colorado SSA units), the Superior National Forest, which accounts for 45 percent of the Northeastern Minnesota unit, revised its forest plan to adopt lynx conservation measures consistent with the LCAS (USFS 2004a, Appendix E). The Okanogan-Wenatchee National Forest in the North-central Washington unit is currently revising its management plan and continues to manage for lynx conservation in accordance with the LCAS, including direction to restore fire to its natural ecological role and to use it as a tool to restore and maintain hare and lynx habitats.

As described above in section 3.1.1, current Federal management on most USFS and BLM lands, in accordance with formally revised or amended management plans, includes limits on the proportion of lynx habitat within LAUs that can be in an unsuitable condition at any given time, including such conditions, usually temporary, created by wildfire. Although some exemptions and exceptions to these limits are permitted for activities to reduce fire risks to communities and infrastructure in the wildland-urban interface (WUI) or to achieve other resource benefits, even these potential impacts are limited on the larger landscape scale (USFWS 2007, p. 7). These conservation measures and the direction to use fire management as a tool to restore hare and lynx habitats and return to natural temporal and spatial patterns of fire disturbance, which were not in place when the DPS was listed, likely further reduce what was even then considered the low potential threat to lynx of past fire suppression activities. Based on the information above, we conclude that fire suppression and other fire management activities have not substantially impacted lynx and hare habitats in the DPS range and are unlikely to do so in the future.

However, warming temperatures attributed to climate change are reducing snowpack, causing earlier snowmelt and longer and more extensive droughts, resulting in longer wildfire seasons and increased fire frequency, size, and intensity in boreal forests of the north and in boreal and montane forests in some parts of the DPS range (Weber and Flannigan 1997, entire; Stocks *et al.* 1998, entire; Gillett *et al.* 2004, entire; Kasischke and Turetsky 2006, entire; Soja *et al.* 2007, entire; Pierce *et al.* 2008, entire; Flannigan *et al.* 2009, entire; Krawchuk *et al.* 2009, entire; Le Goff *et al.* 2009, entire; Bergeron *et al.* 2010, entire; Salathe *et al.* 2010, entire; Abatzoglou 2011, entire; McKelvey *et al.* 2011, entire; Abatzoglou and Kolden 2013, entire; Pederson *et al.* 2013, p. 1815; Price *et al.* 2013, pp. 342-343, 352-354; Barbero *et al.* 2014, entire; Trenberth *et*

al. 2014, entire; Barbero *et al.* 2015, entire; Jolly *et al.* 2015, entire; Lute *et al.* 2015, entire; USEPA 2015, entire; Lienard *et al.* 2016, entire; Littell *et al.* 2016, entire; Westerling 2016, entire; see also section 3.2 above). Increases in fire frequency and size have the potential to adversely affect lynx and hare habitats in the DPS range by rapidly converting large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats (ILBT 2013, p. 70). Although this would likely be a temporary impact, with burned areas subsequently regenerating into higher-quality habitat, it would likely reduce landscape-level hare densities and, therefore, lynx numbers, potentially compromising an area's ability to support a resident lynx population until burned habitats recover.

Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already naturally marginal in many parts of the DPS range, it is possible that very large wildfires or many over a short time period could, perhaps in concert with other influencing factors, tip an area from just barely capable of supporting a resident lynx population to no longer capable of doing so, resulting in extirpation. For example, multiple large fires in north-central Washington over the last 24 years have burned about 34 percent of lynx habitat (Lewis 2016, p. 4), resulting in a more than doubling of estimated female lynx home range size and a two-thirds or more reduction in the number of resident females that potentially could be supported in that geographic unit (Maletzke *in* Lynx SSA 2016, p. 21). It may take 35-40 years for these areas to recover as lynx and hare habitat (Maletzke *in* Lynx SSA 2016, p. 21), during which time additional fire and other habitat impacts could further diminish habitat availability and the lynx population's probability of persistence (Lewis 2016, pp. 5-6; Lynx SSA Team 2016, p. 44; also see section 2.3.2.2, above, and sections 4.1.4 and 5.1.4, below). The loss of habitat resulting from these fires and its potential demographic impacts on the State's only resident lynx population contributed substantially to the Washington Department of Fish and Wildlife's recent recommendation to uplist lynx from threatened to endangered under its State Endangered Species Program (Lewis 2016, entire).

Wildfire frequency, size, and intensity have also increased in the Northwestern Montana/ Northeastern Idaho geographic unit, where about 4,172 km^2 (1,611 mi^2; over 15 percent of the unit) have burned in western Montana from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20). Large fires have also impacted lynx habitat in the Western Colorado geographic unit, where fire size, frequency, and intensity are expected to increase with climate change (Ivan *in* Lynx SSA Team 2016, p. 23). As mentioned in section 2.3.2.2, large areas of the GYA unit were burned by the extensive wildfires of 1988. The extent to which those fires may have diminished lynx and hare habitats and contributed to the recent absence of resident lynx is uncertain, as is the potential for those burned areas to support high hare densities and resident lynx in the future. However, some burned areas may soon develop the dense horizontal conifer structure favorable for hares and, therefore, for lynx foraging habitat, perhaps increasing the likelihood that they may support resident lynx in the near future.

Fire suppression was in the past thought to be a potential risk factor for lynx in the DPS range. However, given the trends discussed above and the likely continued increase in future fire

activity related to continued climate warming, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of lynx populations, especially in places already affected by increased fire activity and those that are naturally only marginally capable of supporting resident lynx.

3.5 Habitat Loss and Fragmentation

Boreal forest habitats in the DPS are patchy and marginal for both snowshoe hares and Canada lynx. In this region, boreal forest transitions to various types of northern hardwood forest. The transitional nature of the boreal forest at its southern extent is believed (along with competition from other hare predators) to limit the numbers of both hares and lynx, preventing either from regularly achieving densities comparable to those regularly achieved in the classic boreal forests at the centers of their ranges in north-central Canada and Alaska (79 FR 54790). Lynx must contend with aspects of their habitat at the southern extent of the boreal forest for which they are not as well-adapted.

Fragmentation has been variously defined to describe a reduction of total area, increased isolation of patches, and reduced connectedness among patches of natural vegetation (Rolstad 1991). “Patchiness” is sometimes used to refer to natural processes (Buskirk *et al.* 2000a, p. 85), whereas “fragmentation” refers to anthropogenic disruption of natural patterns. Habitat loss is conversion of forest to another land use or vegetative cover.

Forest loss and fragmentation are relatively low in the DPS compared to other forested regions in the United States (Heilman *et al.* 2002, p. 416). Since 2000 in the western United States, land uses associated with residential development, roads, and highway traffic have resulted in a 4.5% loss in area (20,000 km^2) of forest, and continued expansion of residential development will likely reduce forested patches by another 1.2% by 2030 (Theobold *et al.* 2011, entire). Human-caused fragmentation in the forested western landscape resulted in a decline of weighted mean patch size from roughly 35,000 to 3,200 km^2 from natural to current conditions, but models predict relatively small declines in the size of forested patches over the next 30 years (Theobold *et al.* 2011, p. 2451). In the eastern United States, nearly half or more of the natural forest was cleared in the past three centuries, but as agriculture and settlement relocated westward and some eastern farmlands were abandoned, eastern forest cover rebounded (Williams 1989, Smith *et al.* 2005). Maine’s forest area has increased 0.79 percent since 1982 (Maine Forest Service, Department of Conservation 2010, p. 25). Similarly, a large portion of Minnesota forests were cleared in the last century, but forest cover has rebounded. The forest area in northern Minnesota has decreased 4 percent since 1977 (Miles *et al.* 2007, p. 22). Preliminary findings from the 2002 U.S. timber assessment (Haynes 2003) indicate that approximately 15 to 20 million acres of U.S. forest land could be converted to urban and developed uses over the next 50 years. Such land use conversions could result from residential development in forested landscapes, as the U.S. population is estimated to grow by another 126 million people.

Habitat patchiness and fragmentation directly affect snowshoe hares and lynx by various mechanisms; reducing hare survival and landscape hare densities, increasing lynx home ranges, reducing lynx reproduction and survival, and affecting lynx movements throughout the landscape. They also increase the diversity of mesocarnivore communities that coexist with lynx and the level of competition for space and food resources. Fragmentation from anthropomorphic sources results in habitat alteration, direct habitat loss, vehicle collisions and behavioral disturbance from roads and changes in landscape features such as edges.

Landscapes in which hare habitat is more contiguous or more broadly-distributed support more hares than landscapes that are more fragmented or include matrix habitats that are of poorer quality (Lewis *et al.* 2011, p. 565). Thus, southern transitional boreal forests generally have lower landscape snowshoe hare densities than boreal forests further north (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84). This may have as much to do with the lower quality of the matrix habitat between high-quality patches as the hare densities that occur in the high quality patches themselves (Lewis *et al.* 2011). Low-quality matrix habitat, typical throughout much of the DPS, could decrease survival for hares, because predators might have higher hunting success or be more numerous and diverse in the matrix habitats (Griffin and Mills 2009). In contrast, a high-quality matrix, typical of Canadian boreal forest, can provide alternative or supplemental resources (Dunning *et al.* 1992; Norton *et al.* 2000), thus supporting higher densities of hares in the prime habitats.

The patchy distribution of hares and differences between landscape hare densities in the contiguous United States require lynx in most areas to incorporate more land area into their home ranges than lynx do in the north to acquire adequate food (Mowat *et al.* 2000, pp. 265, 277–278). At some point, landscape hare densities become too low, making some areas incapable of supporting lynx. Larger home ranges likely require more energy output associated with greater foraging effort (Apps 2000, p. 364) and possibly increased exposure to predation, roads, trapping, and other mortality factors than lynx face in the core of their range.

Throughout the northern part of their range, snowshoe hares are found in continuous areas of boreal forest; conversely, southern populations occur primarily in insular patches of suitable habitat set amidst less-preferred areas (Wolff 1980; Keith *et al.* 1993). This disparity has led a number of biologists to speculate that habitat fragmentation may be ultimately responsible for the non-cycling nature of snowshoe hare populations in the northern U. S. and southern Canada (Dolbeer and Clark 1975; Buehler and Keith 1982; Keith *et al.* 1993, Strohm and Tyson 2009). Wolff (1980, 1981) described the mechanism by which a fragmented habitat might dampen or eliminate cyclic population fluctuations.

Naturally patchy forests and those fragmented by humans may exacerbate competition between lynx and other predators (Buskirk *et al.* 2000a, entire). Forest patchiness, fragmentation, and competition are strongly linked because vegetation mosaics in landscapes provide high quality environments for generalist species such as the bobcat, red fox, and coyote (Goodrich and Buskirk 1995; Buskirk *et al.* 2000a, p. 84). Under such conditions, generalist predators tend to dominate the predator guild in patchy or fragmented landscapes (Oehler and Litvaitis 1996).

Hares fluctuate less dramatically in the southern part of the range of lynx, thus there is more competition for a limited resource and exploitation competition inflicted by generalists (e.g., coyotes) and other predators (Buskirk *et al.* 2000a, p. 95).

Snowshoe hares in the south are concentrated in isolated patches of suitable habitat and subject to predation by a suite of generalist predators (e.g., Litvaitis *et al.* 1985; Sievert and Keith 1985; Keith *et al.* 1993; Cox *et al.* 1997). Keith *et al.* (1993) found that extremely high predation rate on hare living in high quality hare habitats, rather than predation on naturally dispersing individuals, seemed to be driving the changes in distribution and abundance in a snowshoe hare population in Wisconsin. In this study, predation pressure on populations occupying small (<7 ha) patches of preferred habitat was so severe that 3 of the 5 populations under investigation went extinct in the course of the 3-year study. Fragmentation of landscapes exacerbate the effect of predation by allowing carnivores to concentrate their hunting efforts on small patches of habitat used by their preferred prey instead of preying disproportionately on dispersing individuals (Wirsing *et al.* 2003, p. 170). In predator-rich landscapes characteristic of the DPS, this can result in intense predation and competition for a limited prey resource.

Canada lynx seem to be flexible in their response to habitat fragmentation, whereas closely related species, such as bobcats and Iberian lynx, are sensitive to habitat fragmentation (Ferreras 2001, Crooks 2002). In a southern Ontario landscape Hornseth *et al.* 2014 (pp. 8-9) demonstrated that lynx exhibited a wide range of responses to habitat alteration. In general, lynx responded most positively to areas having greater than 50 percent suitable habitat and generally avoided areas having less than 30 percent suitable habitat. However, lynx showed no sensitivity to the degree of forest fragmentation in areas of high or low suitable habitat.

All of these factors likely lead to lower reproductive output and more tenuous conservation status for lynx in many parts of the DPS relative to those in Canada and Alaska (Buskirk *et al.* 2000a, p. 95). Thus, human activities that further fragment boreal forests in the DPS (e.g., climate change, forest management, roads, and development) further reduce the probability of lynx persistence.

The snow environment in the DPS is also patchy and marginal in both space and time for snowshoe hares and Canada lynx. Snow depth (Hoving *et al.* 2005, Peers *et al.* 2013, entire) and duration (Gonzalez *et al.* 2007) give lynx a competitive advantage over generalist predators in the conterminous United States. Too little snow or crusting conditions favor competitors and predators like bobcat, fisher, and coyotes. High elevations may provide snow conditions that favor lynx, whereas low elevations favor conditions for competitors. Lynx may have competitive advantage at higher elevations in the DPS in the winter, but not in summer months when competitors may have free access to all habitats. In contrast, extensive deep, fluffy snow conditions favor lynx in broad areas of north-central Canada and Alaska.

Landscape features further fragment hare and lynx habitat. In lynx units in the western contiguous U.S., potentially suitable boreal forests and appropriate snow conditions occur in relatively narrow elevational bands in the Cascade and Northern and Southern Rocky

mountains. Thus, appropriate habitats for lynx are naturally fragmented by topography and vegetation gradients. These “islands” of habitat can be extensive (e.g., the Okanagan in Washington or most of northwestern Montana) or smaller and relatively isolated (e.g., the Garnet Range in western Montana) depending on topography and precipitation patterns. Some of these areas of boreal forest are separated by unsuitable habitats in the low valleys (e.g., sage flats, urban corridors, agricultural lands) or by snow regimes (e.g. snow shadows) that may restrict lynx dispersal between habitat patches. In some western parts of the DPS range, lynx habitat is also fragmented by rugged, high elevation terrain (Carroll *et al.* 2001, p. 976). In other areas of the DPS where there is little topography, including Minnesota and Maine, matrix forest facilitates lynx movements between suitable habitats. Large rivers are unlikely to fragment habitat as lynx readily swim across large bodies of water (Feierabend and Kielland 2014, entire) or cross them on ice in the winter (Koen *et al.* 2015).

Snow is an important component of lynx habitat (79 FR 54809). Snowfall can be patchily-distributed, variable and unpredictable from year to year, and affected by local topography, water bodies, and climate gradients. Snow conditions that provide lynx a competitive advantage over other terrestrial hare predators are most consistent in the high-elevation regions of the western U.S., although snow alone does not constitute lynx habitat (i.e., many places receive sufficient snow but lack other features lynx need, typically adequate hare densities). Snow conditions are less consistent in the East. For example, lake-effect snow from Lake Superior can increase snow depth and duration in the Arrowhead region of Minnesota in some years, but not others. The Gulf of Maine has the reverse effect, and its warming influence reduces snow depth and duration inland. Distribution models by Hoving (2001, p. 74) indicate that eastern Maine has extensive areas of boreal forest but does not achieve snowfall thresholds that gave lynx an advantage over bobcats and other competitors.

Lynx populations are clearly most viable in areas having extensive, unfragmented boreal forest habitats with large patches of high-quality foraging habitat and persistent deep, fluffy snow. Both lynx and hares are influenced by the spatial arrangement of preferred habitat. In Ontario, lynx preferred habitats with a high degree of connectivity (Walpole *et al.* 2012, p. 769). In Maine and northern Washington, landscapes where habitat was more contiguous supported more snowshoe hares than landscapes that were more fragmented (Simons 2009, Lewis *et al.* 2011). Several studies (Koehler 1990a, Mowat *et al.* 2000, von Kienast 2003, Maletzke 2004, Squires and Ruggiero 2007, Squires *et al.* 2010) have reported that lynx avoid large openings, especially during winter. Mowat *et al.* (2000) suggested that relatively few snowshoe hares use large openings, and consequently lynx spend little time hunting in these areas. Koehler (1990a) speculated that vegetation management prescriptions that result in distance to cover >100 m (328 ft) may change lynx movement and use patterns until such time as sufficient reestablishment of forest vegetation occurs. Opening size can also influence seedling regeneration and stocking densities (Kreyling *et al.* 2008).

Similarly, individual lynx have the smallest home ranges and greatest survival and productivity in landscapes that have extensive, large patches of habitat in combination with deep, fluffy snow. Within their home ranges, lynx strongly select for habitat patches that enhance their

foraging opportunities (Moen *et al.* 2008, Vashon *et al.* 2008a, Fuller and Harrison 2010, Squires *et al.* 2010). Analysis of winter movements of lynx in Maine indicated that lynx responded to habitat heterogeneity at a coarse scale within their home ranges by maximizing their access to snowshoe hare prey (Fuller and Harrison 2010). In Montana, lynx selected homogeneous spruce-fir patches that supported snowshoe hares and avoided recent clearcuts or other open patches (Squires *et al.* 2010). Similarly, in Washington, Lewis *et al.* (2011) reported that landscapes in which hare habitat was more contiguous, or surrounded by a mosaic of similar habitat quality, supported more hares than did more fragmented landscapes.

Anthropogenic Sources of Fragmentation - Human activities can exacerbate the naturally-patchy habitat that is typical throughout much of the DPS range. Anthropogenic activities such as forest management, development, and highways alter natural landscape patterns. They cumulatively can reduce the total area of habitat, diminish the quality of habitat, increase the isolation of habitat patches, and impair the ability of lynx and other wildlife to effectively move between patches of habitat. Anthropogenic fragmentation may be permanent, for example by converting forest habitat to residential, industrial, or agricultural purposes, or temporary, for example by conducting forest management but allowing trees and shrubs to regrow. Habitat fragmentation (both natural and anthropogenic) increases the risk of extirpation of small lynx populations.

Human-caused fragmentation of the already naturally patchy pattern of lynx habitat in the contiguous U.S. can affect lynx by reducing their prey base and increasing the energetic costs of using habitat within their home ranges. Buskirk *et al.* (2000a) identified direct effects of fragmentation on lynx to include creation of openings that potentially increase access by competing carnivores, increasing the edge between early-successional habitat and other habitats, and changes in the structural complexities and amounts of seral forests within the landscape. At some point, landscape-scale fragmentation can make patches of foraging habitat too small and too distant from each other to be effectively accessed by lynx as part of their home range. Maintaining a mosaic of large (>100 acres) patches of young to old stands in patterns that are representative of natural ecological processes and disturbance regimes would be conducive to long-term conservation of lynx (ILBT 2013, p. 77).

Roads, development, climate change, and forest management fragment snowshoe hare and lynx habitat in the DPS. We know little about how hare and lynx respond to these anthropomorphic changes to their habitat, which requires additional research (Murray *et al.* 2008, p. 1464; Squires *et al.* 2013, p. 194). In the next decades, southern lynx populations will incur further habitat loss and fragmentation and the effects of climate change. Changes in habitat, prey base, and competitor guild will further stress southern lynx populations and possibly populations in southern Canada. Ultimately, the extent of such changes and whether lynx are able to adapt to them will determine not how, but if, this species can persist in its current southern range (Murray *et al.* 2008, p. 1469).

Roads - Paved highways fragment lynx habitat. In the West, they typically follow natural features such as rivers, valleys, and mountain passes that may have high value for lynx in

providing habitat or connectivity. They surround large blocks of lynx habitat in Minnesota and northern Maine. Various studies have documented lynx crossings of highways. A male lynx in western Wyoming was documented to have successfully crossed several 2-lane highways during exploratory movements (Squires and Oakleaf 2005). However, in Alberta, Canada, high road densities, human activity, and associated developments appeared to reduce the habitat quality based on decreased occupancy by lynx (Bayne *et al.* 2008). Apps *et al.* (2007) found lynx were 13 times less likely to cross the Trans-Canada Highway relative to random expectation, but only 2.2 and 3.1 times less likely to cross smaller highways (93 and 1A, respectively). In southeastern British Columbia, lynx avoided crossing highways within their home ranges (Apps, 2000). Squires *et al.* 2013 (p. 194) documented 44 radio-collared lynx with home ranges within an 8 km buffer of 2-lane highways, however, only 12 of these individuals crossed the highway.

Paved highways also pose a risk of direct mortality to lynx and may inhibit lynx movement between previously connected habitats. If lynx avoid crossing highways, this could lead to a loss of effective habitat within a home range and reduced interaction within a local population (Apps *et al.* 2007). Lynx and other carnivores may avoid using habitat adjacent to highways, or become intimidated by highway traffic when attempting to cross (Gibeau and Heuer 1996, Forman and Alexander 1998).

Carnivores are especially vulnerable to highway-caused mortality in areas with dense and high traffic volume roadways (Clevenger *et al.* 2001). As the standard of roads increases from gravel to 2-lane or 4-lane highways, traffic volumes and the degree of impact are expected to increase. Walpole *et al.* (2012, p. 770) found that small logging roads with low traffic volume had no effect on lynx distribution. Four-lane highways, such as the interstate highway system, commonly have fences on both sides, service roads, parallel railroads or power lines, and impediments like "Jersey barriers" that make successful crossing more difficult, or impossible, for wildlife (ILBT 2013, p. 78). Alexander *et al.* (2005) suggested traffic volumes between 3,000 and 5,000 vehicles per day may be the threshold above which successful crossings by carnivores are impeded. In Colorado, lynx successfully and repeatedly crossed major highways, including I-70 (Ivan 2011c, d, 2012; J.Squires, personal communication 2012). Colorado lynx crossed two-lane highways an average of 0.6 times per day and more frequently during dusk and night when traffic volume was lower (Baigas *et al.* 2017, p. 204). They also crossed 4-lane highways (I-70), especially forested areas under large, elevated bridges that spanned streams (Baigas *et al.* 2017, p. 204).

Between 2000 and 2015, 54 lynx were reported to have been killed on roads (both paved and unpaved) in Maine (J. Vashon, Maine Department of Inland Fisheries and Wildlife, unpub. data), 11 in Minnesota (T. Smith, U. S. Fish and Wildlife Service, unpub. data), 1 in Idaho and 5 in Montana (compiled by K. Broderdorp, USFWS, unpub. data 2016). Between 1995 and 2011, 15 lynx were reported killed on British Columbia highways (British Columbia Wildlife Accident Reporting System 2012). Most of these mortalities are on higher-speed paved highways. However, in Maine, about 41 percent (22 of 54) were killed on dirt logging roads with low traffic volume and lower speed limits.

Translocated animals may be more vulnerable to highway mortality than resident lynx (Brocke *et al.* 1990), because they often move extensively after their release and are unfamiliar with their surroundings. In the Adirondack Mountains of New York, an attempt to reintroduce lynx failed and 18 of 37 documented mortalities of translocated animals were attributed to road kills (Brocke *et al.* 1990). Over a 7-year period in Colorado, 13 of 102 documented mortalities of translocated lynx were killed on highways (Devineau *et al.* 2010). Traffic volumes on Colorado highways where the 13 lynx mortalities occurred were estimated to range from about 2,300 to >25,000 vehicles per day (K. Broderdorp 2012 , *pers. comm*.).

Roads of all sizes have many indirect effects to lynx including increased human access (e.g. trapping and illegal shooting), and creating edge habitats that promote co-occurrence with competitors like coyotes and bobcats (Bayne *et al.* 2008, p. 1195).

Vegetation Management - As described in section 3.3, above, forest management can further fragment boreal forest in the northern contiguous United States affecting habitat suitability for both snowshoe hares and lynx. Large-scale forest fragmentation or maturation can be deleterious to snowshoe hares because they become increasingly restricted to small patches with adequate cover, and higher predation rates from a variety of carnivores tend to increase local extinction risk (Wolff 1981, Keith *et al.* 1993, Wirsing *et al.* 2002; see also Barbour and Litvaitis 1993).

Although some forest management can benefit lynx by creating or maintaining a shifting mosaic of lynx habitat, it can also be detrimental by fragmenting habitat into small, widely-spaced parcels. Changes to vegetation structure can increase landscape resistance to lynx movements (Squires *et al.* 2013). In Montana, fragmentation from forest thinning decreased the probability of lynx movements across the forested landscape (Squires *et al.* 2013, p. 192). Lynx in the Northern Rockies are sensitive to changes in forest structure and tend to avoid large forest openings (Koehler, 1990; Squires *et al.* 2010) like recent clearcuts and thinned areas. In Maine, the shift to partial harvesting forms of forest management will continue to increase the number of patches of high quality hare habitat, but it will greatly reduce the size of patches and increase their isolation (Simons-Legaard *et al.* 2016, pp. 5-6). This is diminishing landscape conditions conducive to supporting lynx.

Residential and Commercial Development - Residential and commercial development is increasing on private forest lands. Increased traffic and urbanization are projected for the Northern Rockies (Hansen *et al.* 2002) and Maine (also see section 5.2.1, below). It is uncertain to what degree lynx can tolerate habitat fragmentation from roads and clearing forest for development, and how human and pet activity associated with development may affect lynx use of habitats. Some anecdotal information suggests that lynx are quite tolerant of humans, although given differences in individuals and contexts, a variety of behavioral responses to human presence may be expected (Staples 1995, Mowat *et al.* 2000). The degree to which residential development and associated roads reduce connectivity of mesocarnivore populations (including lynx) likely depends on the physical design of highway improvements, the

surrounding environmental features, the density of increased urbanization, and the increased traffic volume (Clevenger and Waltho, 2005; Grilo *et al.* 2009).

Ski Resorts - Ski area development also results in permanent habitat loss and fragmentation. One ski run is often separated from the next only by small inter-trail forest islands. Ski runs often are intermixed with other open areas such as open or gladed bowls, rock outcrops, or barren tundra ridges. Ski resorts that are built or expanded in lynx habitat may impact lynx by removing forest cover, reducing the snowshoe hare prey base, and creating or increasing human disturbance in or near linkage areas. There is limited information on lynx behavior and habitat use in and around ski areas. Lynx have been known to incorporate smaller ski resorts within their home ranges, but may not utilize the large resorts. Preliminary information from an ongoing study in Colorado suggests that some recreational use may be compatible, but lynx may avoid some areas with concentrated recreation use. In some areas, lynx habitat may be limited and concentrated in the ski area development footprint (Squires 2012, *pers. comm.*).

More than 50 ski areas exist throughout the range of the lynx in the contiguous U.S. (ILBT 2013, pp. 82-83). Most ski areas are located on north-facing slopes, where ample snow conditions provide for extended ski/snowboard recreational seasons. In the western states, many of these landscapes feature spruce-fir forests. While ski resorts occupy a small proportion of the landscape, spruce-fir forests provide important habitat for snowshoe hares and lynx at the southern extent of their range. In winter, alpine and Nordic skiing and snowboarding are the primary uses. Most of these resorts offer year-round recreation, with summer activities typically including hiking and mountain biking.

Mining Leasable Minerals - Activities associated with exploration and development of leasable minerals occur primarily in western units of the DPS. Very little mining development occurs in Minnesota and northern Maine. Mining affects lynx habitat by changing or eliminating the native vegetation, human disturbance, and contributes to habitat fragmentation. Development of a high density of wells, as is typical of coal-bed methane development (e.g., 1 well per 2–4 ha [5–10 ac]), could affect lynx by directly removing habitat or causing sufficient human presence to displace lynx. The development of associated roads, powerlines, and pipelines to facilitate exploration and development also result in a loss of lynx habitat and contribute to fragmentation of habitat. In some areas, for example in the Wyoming Range, extensive oil and gas development is occurring within lynx habitat.

Locatable Minerals - Only a fraction of the historical number of mines is operating today. Those that continue to operate do so with more stringent environmental protection measures. However, in some parts of the United States, minerals exploration and new development seem to be increasing. Activities associated with exploration and development of locatable minerals could affect lynx habitat by changing or eliminating the native vegetation, and by contributing to habitat fragmentation. The effects can be variable depending on the size of the associated mining operation or development. Locatable minerals are extracted through both open pit and sub-surface mines with potential habitat alteration ranging from tens to thousands of hectares. In some instances, such as larger mining operations, land exchanges are conducted to

consolidate private ownership of the surface above a deposit prior to mine development. Depending on lands exchanged this could retain lynx habitat in public ownership, but could still result in a net loss of habitat. Development of road and railroad access to facilitate exploration and development also directly impact lynx habitat, contribute to fragmentation, facilitate increased competition as a result of snow-compacted routes, and result in direct mortality. Despite these potential effects, mining exploration and development is generally anticipated to affect only a small portion of lynx habitat in the contiguous United States.

Salable Minerals - In general, salable minerals are found close to the surface. During exploration activities, equipment is moved to the site and a number of test pits are dug or holes drilled to determine the quality of material. If desired minerals are found in suitable quantity, then vegetation is removed and materials are excavated. For example, gravel pits are needed for logging road development and maintenance and are common occurrences throughout areas of the DPS that are in active forest management. Areas developed for salable minerals can vary in size from a single truck load to tens of acres. Impacts to lynx include the potential alteration or removal of lynx habitat, increased fragmentation, and the potential for human-caused mortality from road development.

Wind Energy - Wind energy development and associated transmission lines in lynx habitat is increasing across the nation. Facilities are located on ridge tops or other areas exposed to consistent wind. The construction of wind facilities including access roads may result in loss of lynx habitat and increased fragmentation from permanent forest clearings. Noise and human activity associated with the construction and operation of wind facilities could disturb or displace lynx from important habitats. Effects would likely continue through the life of the project, which may exceed 20 years.

Utility Corridors - Utility corridors contain developments such as overhead or buried powerlines and gas pipelines, and often are located within or adjacent to existing road rights-of-way. Utility corridors potentially could have short- or long-term impacts to lynx habitats, depending on location, type, vegetation clearing standards, and frequency of maintenance. Those that are extensively cleared of vegetation and maintained in grass or herbaceous vegetation likely equate to a permanent habitat loss. When associated with highways and railroads, utility corridors may further widen the right-of-way. Utility corridors may facilitate human access into previously remote areas thus exposing lynx to increased trapping and possible illegal shooting.

Agriculture - Agricultural activity is not expanding currently in lynx habitat areas in the DPS range. In fact, in the late 1800s, over 3 million acres of northern Maine was in farming, compared to about 700,000 acres today (Ahn *et al.* 2002, p. 8). Most of the current farming is in northeastern Maine, where it fragments the forested landscape corridor between core habitats in northern Maine and western New Brunswick, Canada. Forest clearing for agriculture may have contributed (along with increasing road densities and an expansion in coyote distribution) to the recent contraction in the southern part of lynx range in eastern Alberta (Bayne *et al.* 2008, p. 1195).

Habitat Loss and Fragmentation in Corridor Areas Connecting Lynx Populations in the DPS with Adjacent Populations in Canada - Lynx conservation in the contiguous U.S. is thought to depend in part on maintaining connectivity with habitat areas and lynx populations in Canada. Maintaining connectivity for lynx may become increasingly difficult because of climate change and other anthropogenic influences, as evidenced by reduced connectivity for other boreal species (van Oort *et al.* 2011). Potential corridors have been identified in the northern Rockies (Squires *et al.* 2013, entire). There are likely broad, forested corridors with suitable dispersal habitat connecting core habitats in Maine to southern Quebec and northern Minnesota to southern Ontario. Given the perceived importance of lynx immigration from Canada to the persistence of the DPS (FR 68 40076– 40101; Squires *et al.* 2013, p. 187), roads and other forms of habitat loss and fragmentation that may impede lynx movements in the border regions of Canada and the U.S. are of concern.

Chapter 4: Current Conditions

In this chapter, we present our understanding, based on the best available scientific information, including the professional judgment and opinions of lynx experts, of the current status of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the current conditions in each geographic unit, followed by a more detailed evaluation of the status of lynx populations and habitats and the factors currently believed to influence them in each unit. Where appropriate, we compare our current understanding to what was known or believed when the DPS was listed under the ESA in 2000 and to our understanding of historical conditions.

4.1 Summary of Current Conditions DPS-wide

Because of the limitations and uncertainty in the historical records of lynx occurrence in the contiguous U.S. (described above in section 2.3.2.1), it is difficult to compare the current distribution and status of resident lynx populations in the DPS with what may have been the historical condition (but see evaluation in section 2.3.2.2, above). However, research and surveys over the last two decades have significantly improved our understanding of the current distribution, habitats, and the status of resident populations compared to what was known when the DPS was listed in 2000. For example, although we knew there were some resident lynx in Maine (Unit 1), we lacked information on the quality and distribution of lynx and hare habitats and the potential number of lynx. We now know this unit currently has large areas of high-quality habitat created by the regeneration of extensive clear-cutting in the 1970s and 1980s in response to a large spruce budworm outbreak, that there are probably more lynx in Maine now than was likely under historical natural disturbance regimes and habitat distributions, and that this unit currently supports the largest resident lynx population in the DPS. Similarly, when the DPS was listed, we were uncertain whether Minnesota (Unit 2) supported a resident population. We now know that a persistent population of perhaps several hundred lynx occupies the northeastern corner of the state. Research also suggests that lynx and habitats in the western U.S. (Units 3, 4, 5, and 6) are naturally less abundant and more patchily-distributed than was

thought at the time of listing, and several areas thought to have historically supported small resident populations currently do not (the GYA [Unit 5], the Garnet Mountains in western Montana [Unit 3], and the Kettle Mountains of northeastern Washington). We also know that recent extensive wildfires in north-central Washington (Unit 4) have substantially reduced (probably temporarily) the amount of high-quality lynx habitat and likely caused a decline in lynx numbers there. Finally, as a result of the release of 218 Canadian and Alaskan lynx from 1999-2006, and their subsequent survival and reproduction, resident lynx currently occupy parts of western Colorado (Unit 6), although the current number and distribution of lynx there are uncertain.

With regard to redundancy, defined as the ability of the DPS to withstand catastrophic events, we find that the current broad distribution of resident lynx populations in large, geographically discrete areas makes the DPS invulnerable to extirpation caused by a single catastrophic event. The DPS range currently spans the northern contiguous states from Maine to Washington and south along the Rocky Mountains to southern Colorado. Resident breeding lynx populations currently occupy five of the six geographic units (all but the GYA; Figure 1). Of the five occupied units, four are larger than 20,000 km^2 (7,722 mi^2), and the other (North-central Washington) is over 5,000 km^2 (1,931 mi^2) (see tables 2, above, and 4, below). Our analyses and lynx expert imput indicate no single catastrophic event that could result in the functional extirpation (loss of the ability to support resident lynx populations) of the entire DPS and, further, no or a very low likelihood of functional extirpation of any of the individual geographic units caused by a single catastrophic event (Lynx SSA Team 2016, p. 56).

Because we lack evidence that persistent lynx populations have been lost from any other large geographic areas in the contiguous U.S., it also seems that redundancy in the DPS has not been meaningfully diminished from historical levels. That is, the loss of resident lynx populations in the DPS, to the extent suggested by verified historical records, was likely in areas (e.g., northern New Hampshire, the Kettle/Wedge area of northeastern Washington, perhaps Isle Royale in Lake Superior) peripheral to the geographic units that currently support resident lynx. Any small populations that were lost were not in large, discrete geographic units that would have represented substantially greater redundancy in the contiguous U.S. However, the implications of the potential recent loss of resident lynx in the GYA for the redundancy of the DPS are unclear. The historical record and recent research show that the GYA has supported resident lynx. However, it is unclear whether the area consistently supported a resident breeding population over time or whether it naturally supported resident lynx only some of the time ("winked on" in a metapopulation sense) when habitat conditions and hare densities were favorable, and at other times, when habitats and hare densities were less favorable, it did not support resident lynx ("winked off" in a metapopulation sense). Given the protected conservation status of millions of acres in the GYA unit (Yellowstone and Grand Teton National Parks; all or parts of the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie Wildernesses), its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx. If so, the contribution of the GYA to redundancy within the DPS is questionable.

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Representation, defined as the ability of the DPS to adapt to changing environmental conditions, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Lynx experts and geneticists indicated high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Although hybridization with bobcats has been documented in the DPS (in Maine and Minnesota), it is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Further, despite differences in forest community types and other habitat parameters (e.g., topographic/ elevation settings) lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Therefore, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. Because there are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historical conditions, we find that the DPS currently displays an adequate level of representation.

Resiliency, the ability to withstand stochastic disturbance events, is currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. However, because we lack reliable estimates of the sizes and trends of most lynx populations in the DPS, we are unable to use these parameters to evaluate the current resiliency of individual populations or geographic units. Although some demographic data (survival, reproductive rates) are available for each geographic unit (see Table 4, below), they were collected using different methods, at different times and for different intervals, and possibly at different points in hare population cycles or fluctuations and, therefore, do not provide a consistent measure of resiliency. Efforts to understand resiliency within the DPS are also confounded by the metapopulation structure thought to govern lynx populations at the southern margin of their continental range, which suggests that some populations may be naturally ephemeral (i.e., "winked on" when conditions are favorable; "winked off" when conditions are not favorable). The related uncertainty about the extent to which DPS populations may rely on cyclic immigration of lynx from Canada during population irruptions and the ambiguity in the historical record that limits our understanding of the relative persistence of lynx in various geographical areas also limit our ability to characterize, rank, or model the relative contribution of each geographic areas to the resiliency of the DPS.

Despite uncertainties and data deficiencies, qualitative factors provide some hints about current relative resiliency among some geographic areas or parts of them. For example, in Maine, lynx appear to have demonstrated resiliency by responding positively to substantial anthropogenic increases in the amount and distribution of high-quality foraging habitat. Conversely, the current absence of resident lynx in the GYA (Unit 5) and in the Garnet Mountains of Unit 3 may indicate the lower level of resiliency expected among small and relatively more isolated populations. The

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persistence of lynx in north-central Washington (Unit 4) despite the substantial recent wildfire-mediated loss of habitat suggests resiliency in that population; however, the post-fires increase in home range size and likely decrease in lynx numbers may indicate the population is currently less resilient (less able to persist if additional or similar habitat losses occur) than it was previously. Overall, the apparent long-term (historical and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historical conditions suggest adequate historical and recent levels of resiliency of lynx populations in the DPS.

In summary, the lynx DPS currently exhibits adequate redundancy to preclude extirpation as a result of catastrophic events. The genetic health and ecological diversity expressed across the DPS range likewise suggest a currently adequate level of representation. The long-term persistence and apparent broad geographical distribution of lynx populations in four of the six geographic units also suggests the historical and recent adequacy of resiliency in the DPS, although the potential recent extirpation of several small populations may be an indication of inadequate or declining resiliency in those places.

4.1.1 Summaries of Current Conditions in Each Geographic Unit

Unit 1 - Northern Maine: This geographic unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) in northern Maine, but small areas of similar habitat also occur in northern New Hampshire and northern Vermont. Resident lynx in this unit are part of a larger population that also occupies southern Quebec (where trapping is legal) and northern New Brunswick (where lynx are a provincially-endangered species and harvest is prohibited), Canada. There are no reliable estimates of current or historical resident lynx numbers in this unit. At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now know that there currently is sufficient habitat in this unit to possibly support the largest reproducing resident population of lynx in the DPS (numbers and trends unknown, but enough habitat currently exists to support possibly 500 to 1000 lynx). Small numbers of reproducing lynx have also been documented recently in northern New Hampshire and northern Vermont. Historically, when Maine had a greater proportion of mature forest, lynx distribution in this unit was likely patchier, and lynx populations were likely low and dependent on immigration from Canada. Forest management is now the primary driver of hare and lynx habitat in this DPS unit. Current lynx and hare habitat is historically high because of young, regenerating softwood forests created by extensive clearcutting and herbiciding to salvage spruce-fir following a severe spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, Vashon *et al.* 2008b). Lynx responded to these conditions with high survival and reproduction, small home ranges, and moderate population densities. State forestry regulations passed in 1989 caused landowners to shift to various forms of partial harvesting that have resulted in lower landscape hare densities across much of the unit. Hares do not seem to cycle in this region, but underwent a 50 percent decline starting in 2006 and have remained at lower levels. Reproduction and survival rates in the low-hare environment after 2006 suggest a slightly declining population. Unlike other units of the DPS, lynx habitat in northern Maine occurs nearly

entirely on private, industrial forest lands, and landowners do not have long-term commitments to lynx management. The majority of lands in Maine are owned now by investment companies who wish to diversify income from their investments, which could result in forest practices inconsistent with hare and lynx habitat maintenance and conservation. Other potential stressors on private lands include incidental trapping, road mortality, large-scale wind energy development, residential and resort development, and parcelization of forestlands from rapid turnover in investment company landowners. The next spruce budworm outbreak is imminent, but forestry response by investment landowners is uncertain. Climate change is a concern as snow depth and duration are currently at the minimum thresholds believed necessary to give lynx a competitive advantage over bobcats and other mesocarnivores. There is currently no clear evidence of climate change effects on lynx distribution.

Unit 2 - Northeastern Minnesota: This geographic unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps, and black spruce or tamarack bogs. Despite uncertainty when the DPS was listed, it has become apparent that a reproducing resident population of roughly 50 to 200 lynx exists in northeastern Minnesota. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario, where trapping of lynx is legal. Lynx in Minnesota select regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites are associated with regenerating and mixed forest (Burdett 2008, p. 57). Hare densities in parts of northeastern Minnesota appear to be sufficient to support a viable lynx population; and densities are highest in regenerating forests (McCann and Moen 2011, p. 513). The Superior National Forest continues to manage lynx habitats in accordance with its 2004 Forest Plan, which includes measures to minimize several risk factors and promote lynx conservation on the forest. Management of lynx habitat on State and private lands is voluntary and lacks long-term commitments to lynx management. Factors affecting current conditions in this unit primarily include forestry management, roads, incidental trapping, mining development, snow compaction, competition with bobcats, and lynx-bobcat hybridization. Since 2000, 45 lynx mortalities have been documented in Minnesota from unknown causes (16), incidental trapping (11), vehicle collisions (9 on roads and 2 on railroads), and illegal shooting (7). Six lynx radio-collared in Minnesota died after traveling north into Ontario, four from legal trapping/hunting, and two of unknown causes.

Unit 3 - Northwestern Montana/Northeastern Idaho: There are no reliable estimates of current or historical resident lynx numbers in this geographic unit, but it is thought to be capable of supporting 200-300 lynx home ranges. Habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Minor genetic differences suggest three subpopulations in the northwest (Purcell Mountains), central (Seeley Lake), and southern (Garnet Mountains) parts of the unit. No lynx have been detected in the Garnets after 2010, but whether this indicates the extirpation of a small (7-10 individuals) previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Most

(about 90 percent) of this unit, including Federal, State, Tribal, and some private lands, is managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx, with the Garnets being a possible exception. The size and intensity of wildfires have increased over the past several decades, likely in response to climate warming, but impacts to lynx are uncertain. Whether and if so to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit is also unknown. Regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Hare densities have not been estimated broadly throughout the unit but appear to be low or marginal even in what is considered the highest-quality habitat, suggesting that even small decreases in habitat quality/hare densities could influence its continued ability to support resident lynx. The role of past and recent immigration in maintaining the demographic and genetic health of current lynx populations in this unit is unknown, but peaks in cyclic lynx numbers in Canada have declined, especially when compared to the unprecedented irruptions of the early 1960s and 1970s, and there is no evidence of significant immigration into this unit since then.

Unit 4 - North-central Washington: This geographic unit encompasses approximately 5,176 km^2 (1,988 mi^2), 91.5 percent Federally owned. It contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia, directly north of this unit, and maintaining connectivity with Canada is considered important to maintaining lynx populations in this unit. There are no reliable estimates of current or historical resident lynx numbers in this unit, but recent habitat and home range analyses (summarized in Lewis 2016) suggest that it may have been capable of supporting 65-90 lynx prior to recent large wildfires. Those fires affected about 50 percent of the potential lynx habitat, led to increased home range size, and may have reduced the current carrying capacity of this unit to 40-55 lynx. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943). There is significant risk for potential future wildfires to further affect the viability of lynx in this geographic unit. Burned habitats are expected to regenerate back into suitable lynx habitat, but this may take 35-40 years. The Kettle Range to the east of this unit was suspected to have supported a small (likely fewer than 20 individuals) resident population until about 30 years ago when over-trapping may have resulted in its extirpation (Koehler *et al.* 2008, p.1523). Potential impediments to lynx movement between the Kettle Range and the Cascades and British Columbia may make natural recolonization of the Kettle Range unlikely. Results of snowshoe hare research suggest that the hare population density in Washington exists at the low end of the range thought necessary to support lynx reproduction (>= 0.5 hares/ha). The OWNF and CNF, which administer more than 90 percent of lynx habitat in Washington, continue to manage lynx habitat on their forests in accordance with the LCAS. Additionally, the WADNR, which manages approximately 4 percent of lynx habitat in Washington, has developed and is implementing its 2006 Lynx Plan, which is also largely based on the LCAS.

Unit 5 - Greater Yellowstone Area (GYA): There are no reliable estimates of current or historical lynx numbers in this unit but, given its naturally-fragmented potential habitat, generally low hare densities, and the paucity of verified records, it appears unlikely this unit ever supported a large resident population. No lynx have been verified in this unit since 2010, but whether this indicates the extirpation of a small but previously persistent resident population or the temporary loss of an historically ephemeral population is uncertain. Over 97 percent of this unit consists of Federal lands that are currently managed to conserve and restore lynx and hare habitats. Past timber harvest and associated management (thinning, road construction, fire suppression) appear to have had localized impacts but not to have diminished the unit's ability to support resident lynx. The size and intensity of wildfires have increased over the past several decades, predominantly in the northern half of the unit (including the large fires of 1988 in Yellowstone National Park) and likely in response to climate warming, but impacts to lynx are uncertain. Whether and, if so, to what extent other climate-mediated factors have influenced the current condition of lynx populations or habitats in this unit are also unknown. Snow conditions currently appear to be adequate, with most of this geographic unit modeled to have a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12). Hare densities were very low in most of Yellowstone National Park but high in parts of the Bridger-Teton National Forest in the southern half of the unit. The role of past and recent immigration in maintaining the demographic and genetic health of lynx populations in this unit is unknown. This unit lacks direct connectivity to other lynx populations, and there is only anecdotal evidence that irruptions of lynx from Canada resulted historically in immigration into this unit. Some lynx released in Colorado dispersed northward into this unit and temporarily occupied home ranges in areas used previously by native resident lynx, but there is no evidence of reproduction among these lynx.

Unit 6 - Western Colorado: There are no reliable estimates of current or historical resident lynx numbers in this unit. Lynx habitat in Colorado is distributed west of US Interstate-25. This unit is not directly connected to lynx populations in Canada. Compared to the time of listing and completion of the Southern Rockies Lynx Amendment, two bark beetle epidemics have altered large areas of lynx habitat in Colorado. Similarly, large wildfires have reset successional conditions in many areas. Areas affected by beetles that contained multistoried stand conditions likely continue to provide habitat to support snowshoe hares and lynx. Areas affected by beetles and fire require 20 plus years to recover to a point where the stands will again support snowshoe hares. The CPW completed their lynx reintroduction, and based on information generated during on-going studies, and reports received by CPW and the USFS, lynx continue to persist, at least in the San Juan Mountains. However, we believe it is reasonable that lynx continue to occupy all National Forests within the State of Colorado (Odell undocumented pers comm. April 4, 2016), and Rocky Mountain National Park (Shenk 2008, page 3). Habitat that supports snowshoe hares is patchily distributed in this geographic unit, which limits their abundance. Because the majority (90 percent) of lynx habitat in Colorado is under Federal land management, actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within this unit. The USFS manages over 85 percent of the lynx habitat in this unit, providing conservation through the Southern Rockies Lynx Amendment. However, regulatory

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mechanisms for the conservation of lynx are lacking on approximately 3,159 km^2 (1,220 mi^2; over 12 percent) of this unit, including lynx habitats on some BLM and some non-Federal lands.

Table 4. Summary of current conditions in six geographic units within the DPS range.

	Unit 1 - Northern ME	Unit 2 - Northeastern MN	Unit 3 - Northwestern MT, Northeastern ID	Unit 4 - North-central WA	Unit 5 - Greater Yellowstone Area	Unit 6 - Western CO
Unit Size (km^2)	28,909	21,101	26,997	5,176	23,687	25,294
Percent of Unit in Conservation Ownership (i.e., Federal, State, Tribal, Conservation Org.)	10	75 - 90	> 95	> 90	> 95	> 90
Connectivity to Lynx Populations/ Habitats in Canada	Directly connected to lynx habitats/ populations in s. Quebec and n. New Brunswick; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Ontario; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. Alberta and s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	Directly connected to lynx habitats/ populations in s. British Columbia; evidence of natural movement, but rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown	No direct connection; rates of immigration/ emigration unknown
Home Range Size (Adult Female, km^2)	25 - 33	17 - 21	43 - 115	37 - 91	50 (1 female, 3 yrs)	75 - 704
Productivity – Percent Females with Kittens	89% (high hares); 30% (low hares);	100%	83% (Purcells); 61% (Seeley Lake)	100% (2 females)	Few data	24%
Productivity - Litter Size	2.74 (high hares); 2.25 (low hares)	3.3	2.95 (Purcells); 2.24 (Seeley Lake)	2.25 (2 females)	3.0 (1 female, 2 yrs)	2.75
Average Annual Adult Survival Rate	0.80 (high hares); 0.71 (low hares)	0.75 - 1.00	0.85 (Purcells); 0.75 (Seeley Lake)	0.86	Few data	0.93 (in Core Release Area [CRA]); 0.82 (out of CRA)
Lambda (Annual Rate of Population Change)	1.16 (high hares, 6 yrs); 0.88 (low hares, 4 yrs)	No estimate	1.16 (Purcells, 4 yrs); 0.92 (Seeley Lake, 8 yrs)	No estimate	No estimate	No estimate

4.2 Current Conditions - Detailed Descriptions by Geographic Unit

4.2.1 Unit 1 - Northern Maine

The “Northern Maine unit” includes the core, occupied habitat in northern Maine, which is designated critical habitat. It also includes areas where lynx have recently occurred in western and eastern Maine and northern New Hampshire and Vermont. To be consistent with the Workshop Report, we refer to this collective region as the Northern Maine unit.

Unit Description: This unit encompasses northern hardwood and spruce-fir forest (the Acadian forest) primarily in northern Maine, but also small areas of northern New Hampshire and Vermont. Climate in this region is characterized by warm summers and some of the coldest temperatures and highest snowfalls in the eastern U. S.; a function of latitude, elevation, and distance from the ocean. The average terrain rises in northern Maine to 1,000-1,500 feet with mountain peaks, particularly in western Maine, northern New Hampshire and Vermont from 3,000 to 5,000 feet. This region is far enough inland to be unaffected by marine influences. Average annual precipitation is currently 104 cm (41 in), with greatest precipitation in winter in the form of snow (average total snowfall is 228-280 cm (90 -110 in), with higher amounts at the highest elevations. Snow duration is about four months (mid-November through mid-April).

Maine - Much of the lynx habitat in northern Maine occurs within the designated critical habitat boundary, which is approximately 28,909 km^2 (11,162 mi^2) all in northern Maine (79 FR pp. 54823-54828). Land ownership in the critical habitat unit boundary is about 90 percent private, seven percent State (primarily Baxter State Park), one percent Federal (the newly-designated Katahdin Woods and Waters National Monument and Appalachian Trail Corridor), and one percent Tribal (Passamaquoddy Tribe, Penobscot Indian Nation). Private lands are almost entirely commercial forest lands. Lynx regularly occur outside of the designated critical habitat boundary in parts of northeastern, eastern, and western Maine and, recently, in northernmost New Hampshire and Vermont (see below).

New Hampshire - Habitat in northern New Hampshire is not within the designated critical habitat. Potential habitat is limited (Hoving 2001, p. 59), and the few habitat patches that support lynx in New Hampshire are much smaller than those in northern Maine (Litvaitis and Tash 2005, Fig. 2 and p. A–298; Robinson 2006, Fig. 3.3, p. 99). Hoving estimated approximately 1,000 km^2 (386 mi^2) of potential habitat having a greater than 50 percent probability of being occupied by lynx (68 FR 40086). Litvaitis and Tash (2005, p. A–298) estimated that New Hampshire contains about 888 km^2 (343 mi^2) of potential Canada lynx habitat. Historical distribution in New Hampshire included Coos and northern Carroll and Grafton counties (i.e., White Mountain National Forest; Siegler 1971, Silver 1974, Hoving *et al.* 2003). Habitats with the highest probability of occurrence are in Pittsburg in northern New Hampshire and the White Mountain National Forest in the central area of the State (Siren 2014, p. 34). The majority of the habitat in northern New Hampshire is located on the 101-km^2 (39-mi^2) Connecticut Lakes Natural Area (CLNA), which is owned and managed by New Hampshire Fish and Game. Surrounding habitat is owned and managed by the Connecticut Lakes Timber Company under a conservation easement held by the State. Occurrence records from the past 10 years have been centered on these two ownerships (Kilborn 2015, App. A, pp. 42-43). The CLNA includes 61 km^2 (23 mi^2) considered core lynx habitat with a conservation easement under which it will be allowed to mature to a climax forest type potentially providing good denning habitat but restricting the amount of snowshoe hare habitat in the foreseeable future. Current conditions are in a transition state, and portions of the core area currently support higher densities of snowshoe hare because of past forest management (Kilborn 2015, App. A pp. 42-43). Regional-scale modeling suggests that a high component of deciduous forest and insufficient snow conditions in New Hampshire are unlikely to support viable lynx populations over time (Hoving *et al.* 2005, pp. 739, 749).

Vermont – Potential lynx habitat in northern Vermont is not within the designated critical habitat. Recent modeling to determine lynx habitat connectivity in the Northeast suggests that the Nulhegan River Basin contains Vermont's best lynx habitat (Farrell 2012). The 530-km^2 (205-mi^2) area is approximately 20 percent Federal (Nulhegan National Wildlife Refuge), 17 percent State (Vermont Department of Natural Resources), and 63 percent private commercial timber lands (with conservation easement). The future persistence of lynx in Vermont is unlikely because of the patchy and limited amount of potential habitat, climate change (decreasing

snow), trends toward hardwood management, and increasing human disturbance (Vermont Fish and Wildlife 2015, Appendix A5 p. 127).

The Northern Maine geographic unit is directly connected to lynx habitats and populations in southern Quebec and northern New Brunswick, Canada. Lynx in this unit represent the southern extent of a larger cross-border population, most of which occurs in the Gaspe region of southern Quebec and northern New Brunswick (Ray *et al.* 2002, pp. 17-20). Lynx in the northern Maine unit are geographically isolated by the St. Lawrence River from lynx populations in central Quebec (120 km [75 mi] north of Maine). Lynx populations in Maine and eastern Canada are geographically isolated from other lynx populations on the island of Newfoundland (900 km [559 mi] east of Maine), and on Cape Breton Island, Nova Scotia (650 km [404 mi] southeast of Maine) (Koen *et al.* 2015, entire). The closest lynx population in the DPS is located in northeastern Minnesota, about 1,700 km (1,056 mi) west of Maine.

Habitat Description: In the Northern Maine Unit, most lynx occurrence records are found within the broadly described "Mixed Forest-Coniferous Forest-Tundra" cover type (68 FR 40086). This habitat type occurs along the northern Appalachian Mountain range from southeastern Quebec, northern New Brunswick, and northern and western Maine, south through northern New Hampshire. This habitat type becomes naturally fragmented and begins to diminish to the south and west, with a disjunct segment running north-south through Vermont, and a patch of habitat in the Adirondacks of northern New York (McKelvey *et al.* 2000a, pp. 248-250). This area is part of the Acadian Forest Region (Rowe 1972, p. 112-129) representing a transition between northern boreal spruce and balsam fir and southern temperate deciduous forests (Seymour and Hunter 1992, pp. 3-4). Northern Maine is characterized by low-relief, hilly terrain, but with some higher elevations up to 1,600 m (5,250 ft; e.g., Katahdin Highlands, western Maine, White Mountains in central New Hampshire). Higher elevations support a predominantly coniferous forest (white, red, and black spruce; balsam fir; eastern white pine) intermixed with northern hardwoods (red maple, aspen, white birch, sugar maple, beech, and yellow birch). Lowland areas include spruce-fir flats interspersed with peatlands (black spruce, tamarack).

Current lynx and hare habitats are associated with spruce-fir stands repeatedly harvested for forest products. Hares and lynx are associated with stands of regenerating sapling (15–35 years old) spruce-fir forest that provide dense horizontal cover (Robinson 2006, pp. 26–36; Vashon *et al.* 2012, p. 15). Lynx are more likely to occur in large (100 km^2 [40 mi^2]) landscapes having a high percentage (>27 percent) of regenerating forest, and less likely to occur in landscapes with very recent clearcut or extensive partial harvest (Hoving *et al.* 2004, pp. 291–292; Simons-Legaard *et al.* 2013, entire). Regenerating stands used by lynx generally develop after forest disturbance (almost exclusively logging) and are characterized by dense horizontal structure and high stem density within one m of the ground. These habitats support the highest snowshoe hare densities (Homyack 2003, p. 63; Fuller and Harrison 2005, pp. 716, 719; Vashon *et al.* 2005a, pp. 10–11). At the stand scale, lynx in northwestern Maine selected older (11- to 26-year-old), tall (4.6 to 7.3 m [15 to 24 ft]) regenerating clearcut stands and older (11- to 21-year-old) partially harvested stands (Fuller *et al.* 2007, pp. 1980, 1983–1985). At the home range scale, lynx select landscapes having extensive regenerating conifer forest, but also with some

mature conifer forest (Simons-Legaard *et al.* 2013, pp. 572–573). Lynx may select partial harvested and mature conifer stands because of increased ease of travel and prey access along the extensive edges with high-quality (regenerating clear-cut) habitats (Simons-Legaard *et al.* 2013, p. 574).

Most of the high-quality hare and lynx habitat in northern Maine is the result of extensive landscape-scale clearcut timber harvesting in response to a spruce budworm outbreak in the 1970s–1980s (Simons 2009, pp. 64, 218). Many of these clearcuts were also treated with herbicides to promote conifer regeneration by suppressing deciduous tree species. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). Historically, the natural disturbance regime (fires, windthrow, insect outbreaks) resulted in smaller, more frequent disturbances and long intervals between larger disturbances.

Snowshoe hare populations in Maine do not seem to cycle at 10-year intervals, but they have experienced a period of high (1995-2005) and low (2006 to present) populations (Scott 2009, pp. 1-44; D. Harrison, Univ. Maine, unpub. Data; Vashon *et al.* 2012, p. 14). Prior to 2006, several estimates of hare densities in the highest quality, regenerating conifer or mixed forest averaged 1.9 (Homyack *et al.* 2007, p. 8) to 2.1 hares/ha (Robinson 2006, p. 26,). After 2006, hare densities declined by about half in all stand types and have remained at these lower levels (Scott 2009, p. 109; D. Harrison, Univ. Maine, unpub. data). Similar trends were observed in the Gaspe Region of Quebec (Assells *et al.* 2007, entire). In 1990, hare densities in dense, regenerating spruce-fir stands in New Hampshire were 0.5 hares/ha at low and high elevation (Brocke *et al.* 1990, p. 61). More recently, Siren *et al.* (2015) reported lower densities in New Hampshire (0.25 to 0.36 hares/ha) in both montane and lowland spruce-fir. Densities in high elevation (krumholtz, stunted spruce-fir) were only 0.19 to 0.28 hares/ha. Comparable hare density data are not available for Vermont or New York. The average landscape hare density in home range-sized areas occupied by lynx in Maine was 0.74 hares/ha (Simons-Legaard *et al.* 2013, p. 567). Based on these observations, Simons-Legaard *et al.* (2013, p. 576) recommended maintaining landscape hare densities of at least 0.74 hares/ha (or 27 percent of 100-km^2 areas in high-quality hare habitat) to conserve lynx.

Habitat Status: As elsewhere in the DPS, boreal spruce-fir forest habitats in the Northern Maine Unit are patchily distributed and intermixed with northern hardwoods, riparian areas, and peatlands. USFS forest inventory data indicate that over 16,000 km^2 of forestland are classified as spruce-fir in Aroostook, Penobscot, Piscataquis, and Somerset Counties in northern Maine (McWilliams *et al.* 2005, p. 122), although not all of this forest type is in areas occupied by lynx. In a roughly 14,500-km^2 area in northern Maine (approximately 50 percent of the designated critical habitat), Simons-Legaard (2016, p. 9-10) estimated that approximately 3,845 km^2 of the forested landscape was comprised of spruce-fir in a young, regenerating stand condition that provide high quality hare habitat. This habitat is similar to, and contiguous with, forested areas in Quebec and New Brunswick, Canada that support lynx (Hoving *et al.* 2005, pp. 740-741). The current range of lynx in the Northern Maine Unit is associated with areas of deep snowfall,

extensive (100-km^2 [40-mi^2]) forested landscapes, and areas having a high proportion of regenerating conifer-dominated forest that had previously been clearcut and treated with herbicides to suppress hardwoods (Homyack 2003, p. 2; Hoving *et al.* 2004, p. 287).

Lynx habitat in the northern Maine unit is associated with large-scale, intensive forest management (Harper *et al.* 1990, entire; Hoving *et al.* 2004, pp. 291-292; Simons 2009, p. 8; FR 74 8616–8701). Patches of boreal forest in New Hampshire, Vermont, and New York are more highly fragmented and smaller than in northern Maine. These more southerly forests also contain a higher proportion of northern hardwood and are believed to lack an adequate conifer component needed to produce sufficient snowshoe hare densities to consistently support resident lynx populations (Hoving *et al.* 2005, p. 749; Carroll 2007, p. 1100).

In general, landscape scale and home range scale habitat selection by lynx on industrial forest lands reinforce the importance of dense regenerating conifer forest along with a component of mature conifers (Hoving *et al.* 2004, p. 286; Vashon *et al.* 2008b, pp. 1494-1495, Simons 2009, pp.64-110; Simons-Legaard *et al.* 2013, p. 568). Simons-Legaard *et al.* (2013, p. 573) found the probability of lynx occurrence was >50 percent when snowshoe hare landscape densities were >0.74 hares/ha (0.39/ac) and there was >10 percent mature conifer forest. In Maine, lynx selected softwood-dominated (spruce and fir) regenerating stands (Fuller *et al.* 2007, pp. 1983-1985; Vashon *et al.* 2008b, pp. 1492-1495) and adjacent older (11–21 years post-harvest) partially-harvested stands (Fuller *et al.* 2007, pp. 1983-1985). Lynx were more likely to occur in landscapes with abundant regenerating forest, and less likely to occur in landscapes dominated by recent clearcut or partially harvested stands (Hoving *et al.* 2004, pp.289-292). Regenerating stands used by lynx typically developed 15–30 years after harvest (Hoving *et al.* 2004, p. 291), and were characterized by high stem density and dense horizontal cover within 1 m (3 ft) of the ground (Robinson 2006 pp. 33-35, Scott 2009, pp. 81-93; Fuller and Harrison 2010, p. 1276-1278). These habitats supported high snowshoe hare densities (Homyack 2003, p. 53; Fuller and Harrison 2005, p. 716, Vashon *et al.* 2008b, p. 1492; Scott 2009, pp. 24, 32, 36-44). At a landscape scale, lynx habitat selection did not differ between sexes; however, at a home range scale, males tended to use more mature forest dominated by conifers than females, and both male and female lynx tended to avoid mature forests that had a high deciduous component (Vashon *et al.* 2008b, pp. 1492-1493).

During winter, lynx primarily selected tall (4.4–7.3 m [14.5–24 ft]) regenerating clearcuts and established partially harvested stands that were 11–21 years post-harvest (Fuller *et al.* 2007, pp. 1984-1985). Lynx selected against mature second-growth stands (>40 years old), short (3.4–4.3 m [11–14 ft]) regenerating clear-cut or partially harvested stands <10 years post-harvest, and roads and road edges (Fuller *et al.* 2007, pp. 1980, 1983-1985). Research of year-round habitat use yielded similar results, with lynx preferentially using conifer-dominated sapling stands that were 3.4–7.3 m (11–24 ft) in height and supported high densities of snowshoe hares (Vashon *et al.* 2008b, pp. 1492-1495). Lynx tended to forage in areas with intermediate to high snowshoe hare densities (tall regenerating or older partial harvest stands), which afforded lynx with greater mobility and where snowshoe hares were more vulnerable to predation, rather than in the densest stands (short regenerating stands; Fuller and Harrison 2010, pp. 1276-1278).

Denning habitat included various types of coarse woody debris; blowdown, deadfalls, and root wads. In northern Maine, the majority of natal dens (12 of 26) occurred in conifer-dominated sapling stands, and 6 dens were found in mature or mixed multi-story forest stands dominated by conifers (Organ *et al.* 2008, pp. 1515-1517).

Historically lynx habitat in the northern Maine unit was likely uncommon. Both the current amount of high-quality habitat and the lynx population in Maine are likely larger than occurred prior to European settlement, when a relatively smaller proportion of the forest was in an early successional stage (Lorimer 1977, entire; Vashon *et al.* 2012, pp. 45, 56). In the Northeast prior to European settlement, lynx habitat was created and maintained by frequent, small-scale forest gap dynamic events and infrequent, large-scale stand-replacing forest disturbances (Seymour *et al.* 2002, pp. 359-365; Lorimer and White 2003, pp. 54-58). Higher elevation boreal forests often exhibit an even-aged wind-throw phenomenon known as fir-waves (Sprugel 1976, entire). Large, stand-replacing events (fire, wind and ice storms, insect outbreaks) are rare (interval of several hundred to several thousand years) and highly variable in size (Seymour *et al.* 2002, entire; Lorimer and White 2003, pp. 50, 54, 59). Spruce budworm, spruce beetle, beech bark disease, and sugar maple defoliators have been important influences affecting forest landscape patterns (McNab and Avers 1994, Chapter 14). The frequency and intensity of spruce budworm outbreaks, the most likely insect to affect lynx habitat, have been highly variable in Maine and eastern Canada in recent centuries (Blais 1983, entire). In this geographic area, wildfire is less significant as a natural agent of disturbance. The typical fire regime is infrequent surface fires in the dormant season in the hardwood forests, and slightly more frequent but long-interval fires in conifer forests (Kilgore and Heinselman 1990, entire; Seymour *et al.* 2002, pp. 359-365, Lorimer and White 2003, p. 59). For the past several decades, early successional forests and lynx habitat in northern Maine, New Brunswick, and southern Quebec have been created almost exclusively by forest management (Lorimer and White 2003, pp. 42-43).

Favorable habitat conditions for snowshoe hare and lynx in Maine resulted from large-scale salvage cutting (clearcutting) following a spruce budworm outbreak in the 1970s and 1980s (Hoving *et al.* 2004, p. 291). After salvage harvest of the affected trees, a portion of the area was sprayed with herbicide to reduce deciduous competition (Scott 2009, pp. 7, 14). The resulting vegetation was dominated by balsam fir and red or black spruce (Scott 2009, p. 60). This created favorable habitat conditions for snowshoe hares and lynx. Habitat conditions for hares and lynx in the unit improved from the late-1980s to present, benefitting from stand-replacing salvage harvests during the last budworm outbreak (Simons 2009, pp. 122-229; Simons-Legaard *et al.* 2016, entire). During this time period, the percentage of forestland with an average landscape hare density greater than 0.5 hares/ha increased 400 percent (Simons-Legaard *et al.* 2016, p. 7).

Current habitat is likely at historically high levels, but this habitat has peaked and lynx habitat will decline in the near future. In response to the widespread clearcutting in the 1980s, in 1989 Maine passed the Forest Practices Act. This Act regulated clearcutting. Various forms of partial harvesting replaced clearcutting as the predominant form of forest management in northern

Maine. Partially harvested stands (e.g., selection harvest, shelterwood harvest, overstory removal) have a wide range of residual stand conditions, but many have lower conifer stem densities and higher hardwood density than regenerating clearcuts (Robinson 2006, p. 29). On average, partially harvested stands support about 50 percent of the hare densities observed in regenerating clearcuts (Robinson 2006, p. 26-27).

Maine's forest practices shifted dramatically after the Maine Forest Practices Act. Over 95 percent of cutting that occurs now in northern Maine is partial harvesting compared to 59 percent in 1988 (Scott 2009, p. 8; Simons 2009, pp.45-47, 69-71; Simons-Legaard *et al.* 2013). This new cutting regime results in lower landscape densities of snowshoe hares (Fuller 1999, Homyack 2003, Robinson 2006, Scott 2009). Another consequence of partial harvesting is that a much greater acreage needs to be cut annually to attain similar harvest volume (as compared to clearcutting). Annual harvest rates have increased from about 100,000 acres per year (before the Forest Practices Act) to about 500,000 acres per year (after the Act). Thus, 17 years after the Maine Forest Practices Act, much of the forested landscape in northern Maine has been partially harvested.

Long-term, binding land management commitments are lacking in the northern Maine unit. Unlike Federal lands, there is no requirement that private landowners comply with lynx management guidelines, and a Federal nexus for review of forestry projects is almost nonexistent. Furthermore, there continues to be high turnover in forest land ownership (Hagan *et al.* 2005; Nadeau-Drillen and Ippoliti 2006) and little funding to provide incentives or to work with private landowners. As of 2005, there were 23 landowners in northern Maine with land holdings in excess of 100,000 acres including the State, Federal government (White Mountain National Forest south of lynx range), a conservation group (The Nature Conservancy), two tribes (Penobscot Indian Nation and Passamaquoddy Tribe with much land south of lynx range) and 18 private forest landowners (Nadeau-Drillen and Ippoliti 2006, p. 13).

There are short-term commitments to manage lynx habitat in the northern Maine unit. In 2003, Congress passed the Healthy Forest Restoration Act. Title V of this Act designates a Healthy Forest Reserve Program (HFRP) with objectives to: (1) promote the recovery of threatened and endangered species, (2) improve biodiversity, and (3) enhance carbon sequestration. In 2006, Congress provided the first funding for the HFRP, and Maine, Arkansas, and Mississippi were chosen as pilot States to receive funding through their respective Natural Resources Conservation Service (NRCS) State offices. Based on a successful pilot program, in 2008, the HFRP was reauthorized as part of the Farm Bill, and in 2010, NRCS published a final rule in theFederal Register (75 FR 6539) amending regulations for the HFRP based on provisions amended by the bill.

In 2006 and 2007, the NRCS offered the HFRP to landowners in the proposed Canada lynx critical habitat unit in Maine to promote development of Canada lynx forest management plans. Since that time four private landowners, The Nature Conservancy, the Passamaquoddy Tribe, Merriweather LLC, and Katahdin Forestlands successfully enrolled in the program. Collectively,

these land ownerships comprised 2,443 km^2 (943 mi^2), or 9.3 percent of the total designated critical habitat in northern Maine in 2014 (79 FR 54828).

The NRCS required that lynx forest management plans must be based on the Service's ''Canada Lynx Habitat Management Guidelines for Maine'' (McCollough 2007, entire). These guidelines were developed from the best available science on lynx management for Maine. The guidelines required maintenance of landscapes having hare densities that support reproducing lynx populations. Notably, HFRP forest management plans provided a net conservation benefit for lynx, which was achieved by employing the lynx guidelines, identifying baseline habitat conditions, and meeting NRCS standards for forest plans. Plans met NRCS HFRP criteria and guidelines and complied with numerous environmental standards. Plans were reviewed and approved by the NRCS with assistance from the Service. The details of the plans are proprietary and will not be made public per NRCS policy.

Short-term commitments to lynx management will expire in 2016 and 2017. Unlike lynx forest plans on Federal lands, HFRP plans lack long term commitments beyond an initial 10-year contract period. Plans were prepared for a forest rotation (70 years) and include a decade-by-decade assessment of the location and anticipated condition of lynx habitat on the ownership. However, landowners are only committed to a 10-year contract, and long-term commitments to lynx management are voluntary. Some landowners developed plans exclusively for lynx, and others combined lynx management (umbrella species for young forest) with American marten (umbrella species for mature forest) and other biodiversity objectives. All four plans have been completed and contracts with NRCS will expire in 2016 and 2017. Landowners have the option to convert HFRP contracts into Safe Harbor Agreements or other agreements to provide regulatory assurances, however, at this time this option has not been explored with landowners.

Many large private forest landowners in the northern Maine unit could potentially include lynx management as part of endangered species management required by forest certification programs. For example, The Nature Conservancy land enrolled in the HFRP is also enrolled in the Forest Stewardship Council (FSC) forest certification program, which requires safeguards for threatened and endangered species. Other landowners are certified under the Sustainable Forestry Initiative (SFI). Both certification programs require planning for threatened and endangered species. However, certification programs are also voluntary and may not include long-term commitments. Few certified landowners have consulted with the Service on forest management for lynx. Given the frequent turnover in Maine forest lands, new landowners do not always renew certification or resume the certification programs initiated by the previous landowner.

Lynx Status: Historically, Maine seems to have consistently had a breeding population of lynx. Early written accounts did not consistently distinguish bobcats from lynx (Hoving 2001). Prior to 1939, lynx observations were based largely on written accounts of lynx from museum records, journals, and periodicals (Vashon *et al*. 2012, p. 56). Hoving *et al*. (2003, pp. 368-369) compiled 118 lynx occurrence records (509 individual lynx) from 1833-1999, which suggest that lynx were widespread throughout the state except for coastal areas. These records included 39 kittens

representing at least 21 litters, primarily in northern and western Maine, from 1864-1999 (Hoving *et al*. 2003, p. 371). Populations apparently fluctuated, and in some years 200-300 lynx were harvested in Maine (Hoving *et al*. 2003, pp. 373-374). Lynx were later documented in winter snow track surveys conducted by MDIFW during 1994-1998 (Vashon *et al*. 2012, p. 56).

At the time of listing, lynx were known to be present in northern Maine but little was known about their distribution, population size, and trend, snowshoe hare populations, and relationships to forest management. Since then, research from the Maine Department of Inland Fisheries and Wildlife (Vashon *et al.* 2008a, entire; 2008b, entire; and 2012 entire) and the University of Maine (Hoving *et al.* 2003, entire; Hoving *et al.* 2004, entire; Hoving *et al.* 2005, entire; Homyack *et al.* 2005, entire; Homyack *et al.* 2007, entire; Homyack *et al.* 2006, entire; Fuller *et al.* 2007, entire; Fuller *et al.* 2004, entire; Fuller and Harrison 2005, entire; Simons-Legaard *et al.* 2013, entire; Simons-Legaard *et al.* 2016, entire) have greatly increased our knowledge. Snow track surveys and confirmed occurrence records (Vashon *et al.* 2012, entire; Siren 2015, entire) document that lynx occur throughout northern Maine and in small, isolated pockets in western and eastern Maine, northern New Hampshire, and Vermont (Siren 2015, entire). Population size and trends are still uncertain.

The Northern Maine Unit currently supports a breeding population of lynx that encompasses most of northern Maine, with recent lynx occurrence and reproduction also documented in northernmost New Hampshire and Vermont. This geographic unit is part of a larger, contiguous lynx population that extends into northern New Brunswick and the Gaspe region of southern Quebec. Extensive areas of contiguous forestland in this region provide high connectivity between populations in Maine and Canada. Lynx populations in adjacent southern Quebec may exhibit cyclic populations (Ray *et al*. 2002, entire), but obvious immigration of large numbers of lynx into Maine associated with hare cycles (if they occur) has not been documented (Hoving *et al*. 2003, pp. 373-374). Although potential lynx habitat in New Hampshire and Vermont is fragmented, there is near contiguous forest and connectivity for lynx movement between these areas and habitats in northern Maine (Farrell 2013, *pers. comm.*; 79 FR 54821). Breeding lynx in New Hampshire and Vermont are not directly connected to Canadian populations, but they are connected to the larger population in northern Maine via habitat corridors in western Maine.

Lynx in the Northern Maine Unit and adjacent populations in southern Quebec and northern New Brunswick are separated from lynx populations in the interior of Canada. The St. Lawrence River restricts lynx dispersal and demographically isolates this population from those in northern Quebec, Labrador, and Ontario. However, sufficient numbers of individuals cross the river on the ice each generation to prevent genetic drift of this population (Koen *et al.* 2015).

At the time of listing, the Northern Maine Unit was not believed to contribute significantly to the DPS. However, we now believe that the extensive young, regenerating spruce-fir habitat created by large-scale clearcutting in the 1970s and 1980s may currently support the largest lynx population in the DPS, numbering at least several hundred and perhaps more than 1,000 resident lynx (Vashon *et al.* 2012, pp. 58-59, Appendix IV; Vashon *in* Lynx SSA Team 2016, p. 18) . Habitat in northern Maine can support lynx densities in localized areas of high-quality

habitat that are substantially greater than densities elsewhere in the DPS (LCAS 2013, p. 23). In 2003 when hare populations were high, lynx density (juveniles and adults) in one of Maine's highest-quality habitats was estimated to be 9.2-13.0 lynx/100 km^2 (Vashon *et al.* 2008a, Vashon *et al.* 2012, p. 15). At about the same time, the density of lynx in nearby Gaspe Peninsula, Quebec was estimated to be 10 lynx/100 km^2 (Ray *et al.* 2002). These densities are intermediate to those in Canada during the high (17.0-44.9/100 km^2) and low periods (2.3-3.0/100 km^2) of the lynx-hare cycle (Poole 1994, Slough and Mowat 1996, O'Donaghue *et al.* 1997). Simons (2009, p. 102) estimated that habitat on a 14,407-km^2 (5,563-mi^2) study area (about half of the critical habitat area designated in 2014) in northern Maine could potentially support a population of 236 to 355 adult lynx, and Vashon *et al.* (2012, pp. 58-59 and Appendix IV) estimated the potential for a population of 750 to 1,000 adult lynx in all of northern Maine in 2006. The actual number of lynx is unknown because there are no methods available to measure and produce true population estimates over such a large geographic area.

Lynx seem to have maintained a similar distribution throughout northern Maine since the 1970s, and are found primarily north of Moosehead Lake and west of Interstate 95, with scattered pockets in western and eastern Maine (Hoving *et al*. 2003, p. 369; Vashon *et al*. 2012, pp. 10-12.) Resident lynx in small pockets of habitat outside of the core range in Maine may occur only ephemerally, winking on an off over time as would be expected at the periphery of the range of a mainland-island metapopulation structure, and as suspected for other lynx populations at the periphery of the range (McKelvey *et al*. 2000b, pp. 25-31; Apps 2007, pp. 81, 95-104). From 1995-1998 and 2003-2008, the Maine Department of Inland Fisheries and Wildlife conducted snow track surveys in 66 townships to document the distribution of lynx and to inform habitat modeling at the University of Maine (Vashon *et al*. 2012, p. 91). Modeled areas of potential lynx habitat were well-distributed throughout northern Maine in the early 2000s (Simons-Legaard *et al*. 2016, entire; Simons 2016, entire).

Lynx populations in New Hampshire and Vermont may consist of only a few animals and they may be ephemeral, although breeding has been documented in both locations in recent years. Most historical lynx records from New Hampshire are from trapping records from the 1930s to the 1960s (Brocke *et al.* 1993, McKelvey *et al.* 2000a, pp. 212-214). There were only two records in the 1990s. In 2003, the Service determined that, despite a lack of breeding records, a small resident population likely occurred historically in New Hampshire but no longer exists (68 FR 40087). Lynx were detected in northern New Hampshire in 2006 and have occurred there annually since (Siren 2014, pp. 53, 55). In 2011, 4 lynx kittens were observed in Pittsburg and were considered evidence of breeding in New Hampshire (Kilborn 2015, Appendix A, p.44). There were only four historical records of lynx in Vermont prior to 2003. Since then, nine lynx sightings have been confirmed, and reproduction was first confirmed in 2012 in the Nulhegan Basin when the tracks of three lynx, a presumed family group, were observed travelling together in late February (Vermont Fish and Wildlife 2015, Appendix A5, p. 126). Since 2012, more intensive surveys in Vermont have resulted in only a single photograph of a lynx in 2014 (Bernier 2015, pp. 1-3; Bernier 2016, *pers. comm.*).

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Resident lynx do not presently occur in New York. A resident population reportedly occurred historically in the Adirondack Region of northern New York, but it was considered extirpated by 1900 (Brocke 1982, McKelvey *et al.* 2000a, pp. 215-217). However, there are 23 verified lynx occurrences since 1900, primarily from the Adirondack Mountains, including the most recent verified record from 1973 (McKelvey *et al.* 2000a, p. 216. Habitat and prey conditions were deemed suitable for a lynx reintroduction in 1989–1991, when 83 lynx were released into the Adirondacks over three winters (Brocke 1982). The reintroduction was unsuccessful in establishing a resident population, and in 2003 the Service concluded that a resident population may have existed in New York prior to 1900, however, records of lynx since 1900 likely represent dispersers (68 FR 40087).

Maine lynx had spatial and demographic parameters similar to some northern populations during the cyclic high in the snowshoe hare cycle (Brand *et al.* 1976, Parker *et al.* 1983, O'Donaghue *et al.* 1997). From 1999 to 2011, biologists with the Maine Department of Inland Fisheries and Wildlife trapped and radio-marked 85 lynx in northern Maine and documented lynx movements and home range (Vashon *et al.* 2008a, entire), resource use (Vashon *et al.* 2008b, entire), survival (Vashon *et al.* 2012, pp. 18-21), productivity (Vashon *et al.* 2012, pp. 17-19), and other aspects of their life history (Vashon *et al.* 2012, entire).. During the period when snowshoe hare populations were highest (2000-2006), Maine lynx had among the highest reproductive rates (average litter size 2.74, 89 percent of adult females producing litters) in the DPS (Vashon *et al.* 2012, pp. 18-19). During the current (2006-present) period of low hare density, litter size was smaller, only 30 percent of females had litters, and mortality was greater. Maine lynx have among the smallest home ranges documented in the DPS (Vashon *et al.* 2008a, p. XX; LCAS 2013, p. 24; also see Table 3, above). Home range sizes were similar during periods of high and low hare density (Mallett 2014). Lynx populations likely increased during the period of high hare density (lambda [λ] = 1.16) and declined during periods of low hare density (λ = 0.88) (USFWS, Vortex10, deterministic population simulation 2016; demographic data from Vashon *et al.* 2012).

In summary, Maine lynx and hare habitats are believed currently to be at historical highs. In the Northeast prior to European settlement, lynx habitat was created and maintained by small-scale, frequent forest gap dynamic events and large-scale, infrequent (stand-replacing) forest disturbances (Seymour *et al.* 2002, Lorimer and White 2003). Historically, lynx distribution was patchy, and lynx populations likely fluctuated and were dependent on immigration from Canada. Current habitat is the result of widespread clearcutting to salvage spruce and fir damaged by a spruce budworm outbreak in the 1970s and 1980s and subsequent use of herbicides to suppress hardwoods (Hoving *et al.* 2004, Vashon *et al.* 2008b). Maine lynx at multiple scales select extensive areas of regenerating, dense (7,000 – 14,000 stems/ha) spruce-fir stands 15 to 35 years after clearcut or other even-aged harvest (Hoving *et al.* 2005, Fuller *et al.* 2007, Vashon *et al.* 2008b, Simons-Legaard *et al.* 2013). Lynx habitat is expected to remain stable for the next few years then decline because of changing forest practices (Simons-Legaard *et al.* 2016).

<u>Factors Affecting Current Conditions</u>

Climate Change - Climate change is affecting temperature, snow, and precipitation patterns in the Northeast at rates faster than expected (Rustad *et al.* 2014). Rapid winter warming in recent decades is believed to be caused by reduced albedo effect caused by the diminished persistence of snow in winter (Hayhoe *et al.* 2006). Average winter temperatures are increasing 0.42-0.46º C/decade with the greatest warming occurring in the winter months (especially January and February; Burakowski *et al.* 2008). Under mid- to high-emissions scenarios, average mean temperatures in northern Maine are projected to increase by 12 to 14 degrees F by 2080-2099 relative to 1971-2000 (Galbraith *et al*. 2013, p. 43). Under a higher emissions scenario, snow covered days in northern Maine (December to February) could decrease from 30 days per month (100% of the time) observed from 1961-1990 to about 18-20 days per month in 2070-2099 (Galbraith *et al*. 2013, p. 49). Climate change has, and will continue to affect lynx by reducing snow and boreal forest (see section 5.2.1).

Snow Duration, Depth, and Quality - As noted in chapter 2, lynx occur where there is regularly at least four months (120 days) of continuous snow coverage (Gonzalez *et al.* 2007). Snow cover days in northern New England (1965-2005) ranged from 60-121 days and declined an average of 3.6 days/decade from 1965-2005 (Burakowski *et al.* 2008). Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005) and is expected to diminish another two weeks in Maine by mid-century (Fernandez *et al.* 2015). Thus, average conditions in Maine are currently at or below the snow persistence thresholds believed to be needed to support lynx (Gonzalez *et al.* 2007). Similarly, the largest decreases in snow depth observed in Canada in the last six decades have occurred in the lower St. Lawrence Valley, immediately north of Maine (Brown and Braaten 1998, pp. 48-52).

Lynx in the Northeast U.S. and eastern Canada occur where there is regularly total snowfall of at least 270 cm/yr (106 in/yr; Hoving *et al.* 2005), which defines the distribution of lynx (to the north) and bobcat (to the south) in this region (Hoving *et al.* 2005, Carroll 2007, Peers *et al.* 2013). Average annual snow depth at all five NOAA weather stations within the range of the lynx in northern Maine (1981-2010) was below this threshold and ranged from 228-263 cm (90-104 in; NOAA 2011, http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html, https://www.currentresults.com/Weather/Maine/annual-snowfall.php, last accessed 31 March, 2016). In the last 50 years, 18 of 23 snow sampling sites in and near Maine experienced reduced depth of snowpack (Hodgkins and Dudley 2006). Snow depth in New England (1965-2005) declined an average of 4.6 cm/decade (1.8 in/decade; Burakowski *et al.* 2008). Thus, average snow conditions in Maine are currently at or below snow depth thresholds for lynx, and further declines in annual snow depth would be expected to reduce the probability of lynx persistence in the region (Hoving *et al.* 2005).

As noted in chapter 2, deep, fluffy snow provides lynx with a competitive advantage over bobcats and gives snowshoe hares the ability to reach winter browse. Snow quality ("fluffiness") has deteriorated in the Northeast. Unlike other units, annual precipitation in Maine is increasing because of climate change, but primarily as rain (A. Siren *in* Lynx SSA Team 2016, p. 15; Fernandez *et al.* 2016), and especially rain on snow events in winter in northern Maine

(Huntington and Hodgkins 2004, Deser *et al.* 2013, Fernandez *et al.* 2015). Snow density and compaction and crust conditions (caused by wet, heavy snow or rain on snow events in winter) have increased in northern New England (Dudley and Hodgkins 2002, Huntington *et al.* 2004, Huntington 2005, Hodgkins and Dudley 2006) and southern Canada (Karl *et al.* 1993).

Vegetation Management - The effects of forest management on foraging and denning habitat for lynx in northern Maine are discussed in the Habitat Description and Habitat Status sections above.

Wildland Fire Management - Although fire is frequent in many boreal forest regions, it is not a stressor for lynx in northern Maine. Annual precipitation is comparatively greater in this unit than others, and conditions for fire are infrequent. The fire regime in this unit is infrequent (50- to 200-year interval) and generally small (several acres) surface fires in the dormant season. Large (up to 80,000 acres) stand-replacing fires are rare and occur at a less frequent interval (800- to 9000-years) (Seymour *et al.* 2002, p. 360). In contrast, spruce budworm outbreaks cause stand-replacement over large areas every 100–250 years (Cogbill, 1985).

Habitat Fragmentation - Habitat fragmentation (smaller and more isolated patches of high quality hare habitat) caused by current forest practices in northern Maine is discussed in the Habitat Description and Habitat Status sections above.

Other Factors: *Trapping* - This unit is directly connected to lynx habitats and populations in southern Quebec, where trapping of lynx is legal. Several lynx that were captured and radio-tagged in northern Maine were subsequently trapped in southern Quebec (Vashon *et al.* 2012).The lynx trapping and hunting seasons were closed in the Northern Maine Unit (including New Hampshire and Vermont) for decades prior to lynx being listed as a threatened species. Hunting and trapping were discontinued in Maine in 1967 (Vashon *et al*. 2012, p. 28). Carroll (2007) modeled lynx populations in this unit and demonstrated that increased trapping pressure in Quebec could have a negative effect on protected lynx populations in Maine and New Brunswick. About 400 lynx are trapped and killed annually in Quebec south of the St. Lawrence River (http://mffp.gouv.qc.ca/english/wildlife/statistics/index.jsp last accessed May 19, 2016).

In 2014, the Maine Department of Inland Fisheries and Wildlife (MDIFW) worked with the Service to develop an *Incidental Take Plan for Maine's Trapping Program* (MDIFW 2014a, 2015b as amended, entire) and obtained a permit from the Service for lynx trapped incidental to other furbearer trapping in Maine. From 2000 to 2016, 114 lynx have been reported captured in traps set for other species and 8 of those were killed (Vashon *et al.* 2012, MDIFW 2014, p. 75). In Maine, after two lynx were killed in killer-type traps in 2014, the MDIFW imposed additional trapping restrictions to further reduce mortality and injury of incidentally-trapped lynx, (e.g., requiring killer-type traps be placed in exclusion boxes, eliminating the use of drag sets for foothold traps, and requiring multiple swivels on trap chains. No lynx have been reported incidentally trapped in New Hampshire or Vermont since 2000.

In areas where lynx are trapped for furs (Canada and Alaska), trapping can be additive to other sources of mortality and have population-level effects (Brand and Keith 1979, Koehler and Aubrey 1994). Thus, harvest regulations for lynx are modified (e.g., lynx quotas per trapper are reduced) when hare and lynx populations are low (Bailey *et al.* 1986). Trapping injury and mortality are not believed to have a population-level effect on lynx in northern Maine and adjacent Canada when lynx may be at historically high numbers, but trapping could have a synergistic and negative effect if hare and lynx populations decline, habitat declines, or climate change further stresses lynx (Slough and Mowatt 1996, Carroll 2007).

Wind Power Development - In response to climate change, interest in wind energy development has increased in northern and western Maine, posing a potential threat to high- and low-elevation spruce-fir habitats (Whitman *et al.* 2013). Maine has experienced a rapid increase in wind energy development (http://www.eia.gov/electricity/data/browser, last accessed August 2, 2016), and there is increased interest in placing developments on private lands in unpopulated areas in northern Maine, New Hampshire, and Vermont. Wind energy is an increasingly appealing source of income for investment companies and other landowners who own forestland in the northern Maine unit. As of 2016, at least 11 wind projects have been proposed in northern Maine and five projects are in operation; two have been proposed in northern New Hampshire and two are in operation; and three have been proposed for northeast Vermont and two are in operation or under construction. Maine's two largest wind projects (combined over 300 turbines covering 932 km^2 [360 mi^2]) are proposed entirely within Maine's designated lynx critical habitat. The effects of wind energy projects on lynx, hares, and their habitats are unknown. Potential direct effects include disturbance or displacement of resident lynx from large landscapes and loss and fragmentation of habitat from turbines, roads, and transmission lines. Increasing power infrastructure associated with these projects could greatly change development potential and patterns in northern Maine by bringing electricity into the interior of Maine's vast undeveloped forest region. Extensive road construction would further fragment habitat and increase access for recreation, including trapping.

Changing Land Ownership and Development - Until recently, the northern Maine unit was largely undeveloped and owned by about a dozen large, industrial forestland owners, but land ownership patterns have changed dramatically in the last 15 years (Nadeau-Drillen and Ippoliti 2006). Large tracts of land have been sold, lumber and pulp mills shut down, and much of the area has been sold to investment-oriented owners. Some investment-oriented landowners are seeking diversified financial returns on their investment, including developing residential housing, second homes, and resorts. Two large residential and resort areas have been proposed on forestlands within the Maine critical habitat area. Both development projects would result in the development of several thousand acres of potential lynx habitat, but would be mitigated by substantial (100,000s of acres) conservation easements on surrounding forestland. A private landowner recently donated 354 km^2 (137 mi^2) within designated lynx critical habitat that was subsequently designated as the Katahdin Woods and Waters National Monument. This area currently has a legacy of young-regenerating spruce-fir habitat from previous industrial forest landowners, but its new monument designation may limit future forest management activities (timber harvest or other vegetation management) that could benefit lynx. Another

conservation landowner, The Nature Conservancy, continues forest management on about half of its 750-km^2 (290-mi^2) ownership, including managing part of the area for lynx.

Construction or expansion of developed areas such as residential areas and resorts and smaller recreational sites like Nordic ski huts or campgrounds may directly remove forest cover. Such habitat alteration and associated human recreation in lynx habitat could decrease prey availability, affect lynx movement within home ranges, result in a more fragmented landscape, affect lynx movement, or displace them from high quality habitats. Development further fragments habitat from road and highway construction (along with associated increases in traffic volumes and/or speeds) and increases the probability of road mortality.

In summary, lynx were historically and are currently widespread throughout northern Maine, and they currently occur (and probably occurred historically) as small resident or ephemeral populations in small patches of habitat in eastern and western Maine, northern New Hampshire, and northern Vermont. Habitat in northern Maine may currently support a potential population of 500 to 1000 lynx, although the actual population size is unknown. Habitat created by extensive clearcutting 30 to 40 years ago is peaking and will decline by 50 percent in the next 15 to 20 years (Simons-Legaard 2016, pp. 10-18; also see section 5.2.1, below). Furthermore, hare populations declined by 50 percent starting in about 2006 and have remained at lower levels. Future hare fluctuations or cycles are uncertain. Recent history demonstrates that some forms of forest management have the potential to create lynx habitat, but forest practices have shifted to partial harvesting, which is less likely to maintain or create high-quality lynx habitats, and private landowners do not have long-term commitments to manage for lynx conservation. Land ownership has dramatically changed in northern Maine, and the majority of lands are owned now by investment companies who wish to diversify income from their investments, which could result in forest practices inconsistent with lynx habitat conservation. The greatest stressors to resident lynx in this unit are habitat loss (shifts in forest management from clearcutting to partial harvesting resulting in lower landscape hare densities), lack of forest planning for lynx, and projected continued climate warming (diminishing snow depth, quality and duration; competition from bobcats and fishers; loss of spruce-fir to northern hardwoods; and future isolation of the metapopulation because of diminishing ice conditions on the St. Lawrence River).

4.2.2 Unit 2 - Northeastern Minnesota

Unit Description: This unit encompasses approximately 21,100 km^2 (8,147 mi^2) in northeastern Minnesota. It includes the area designated as critical habitat in 2014 (79 FR 54782) and an additional relatively small area of tribal land in northern Minnesota that was excluded from critical habitat. Land ownership in this unit is about 47 percent Federal (primarily USFS, with some NPS and BLM land); 36 percent State; 16 percent private; and 1 percent Tribal (Grand Portage Reservation) (see Table 2). This unit includes most of Superior National Forest (SNF; including the Boundary Waters Canoe Area Wilderness [BWCAW]) and Voyageurs National Park. This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit likely represent the southern extent of a larger cross-border population, most of which occurs in Ontario (ON). Relative to other DPS lynx populations, this unit is about 1,480 km (920

mi) east of the Northwest Montana/Northeast Idaho Unit and about 1,610 km (1,000 mi) west of the Northern Maine geographic unit.

Habitat Description: In Minnesota, most lynx occurrences are associated with the Mixed Deciduous/Conifer Forest (McKelvey *et al.* 2000a, pp. 246, 248) within the Laurentian Mixed Forest Province (McNab *et al.* 2007, p. 5). Most of this province is characterized by low-relief hilly landscapes with glacial features and an elevation from sea level to 730 m (2,400 ft), including many lakes and rivers. This unit contains a mix of upland conifer and hardwood interspersed with lowland conifer, alder or willow shrub swamps and black spruce or tamarack bogs. Coniferous and mixed-coniferous/deciduous vegetation types are dominated by balsam fir; black and white spruce; northern white cedar; Jack, white and red pine; hemlock; and tamarack; mixed with aspen and paper birch (Burdett 2008, p.5; Moen *et al.* 2009, pp.1-2; McCann and Moen 2011, p. 510). Burdett (2008, p. 57) reported that lynx in Minnesota selected regenerating forest, dominated by conifer with extensive forest edge; lynx beds (resting and hunting) and kill sites were associated with regenerating and mixed forest. McCann and Moen (2011, p. 513) found snowshoe hare densities were highest in regenerating forests. Females selected large woody debris and dense horizontal cover in lowland conifer cover for denning in northern Minnesota (Moen *et al.* 2008, p. 1510), but other cover types were used if recent blowdowns were present (Moen and Burdett 2009, p. 5).

Hare density in parts of northeastern Minnesota appears to be sufficient to support a viable lynx population (Moen *et al.* 2008, p. 1512), with stand-level densities ranging from 0.3–2.0 hares/ha (0.12–0.8 hares/ac; McCann 2006, p. 17). Hare populations in northeastern Minnesota appear to be patchily distributed, but are most consistently abundant in 10-30 year old regenerating forests (McCann 2006, p.45). Pellet count data prior to the 1990s show evidence of density fluctuations of snowshoe hare populations occupying Minnesota (Fuller and Heisey 1986, pp. 262-263), but these fluctuations were not observed during the 1990s (Hodges 2000a, p. 172). Snowshoe hare habitat in Minnesota primarily consists of conifer forests with dense low-growing understories, lowland shrub and conifer bogs. Conifer bogs or lowland conifer forests may be especially important during low points in hare cycles by acting as refugia for hares. Early regenerating or pole-sized stands are not used as much as in other portions of their range, although older regeneration stands were used frequently in Minnesota (McCann 2006, p. 45). Sapling-sized aspen adjacent to conifer cover may also provide functional snowshoe hare habitat. McCann and Moen (2011, pp. 512-513) mapped the distribution of predicted snowshoe hare habitat across northeastern Minnesota. In northeastern Minnesota, edge habitats and regenerating conifer stands appeared to be important for snowshoe hare populations (Burdett 2008, p. 58; McCann 2006, p. 45), as were dense habitats containing balsam fir, white spruce, and cedar (Fuller and Heisey 1986, p. 263). Recent research indicates that the red squirrel is not an important prey species for lynx in northeastern Minnesota (Burdett 2008, p. 62; Hanson & Moen 2008, p. 9).

Average annual snowfall in this unit ranges from about 180 cm (71 in) in the northwestern part of the unit near International Falls, Minnesota to 219 cm (86 in) in Duluth, Minnesota, on the southern end of the unit, to 228 cm (90 in) in Tofte, Minnesota, near the lake shore on the far

eastern-central part of the unit, to 228 cm (90 in) in Isabella, Minnesota, near the center of the unit, to the 107 cm (42 in) in Grand Portage, Minnesota, at the northeastern tip of the unit. More snow is produced along Lake Superior, because of the lake effect (https://snowfall.weatherdb.com/d/a/Minnesota; accessed 4/25/2016).

Habitat Status: Friedman and Reich (2005, p. 732) conducted a spatially explicit forest composition change analysis on a 3.2 million hectare study area in northeastern Minnesota, which was based on General Land Office Survey records from the late 1800s and the 1990 USFS Inventory and Analysis Survey. The study documents altered forest tree species abundance, proportional basal area, and spatial distribution patterns. The proportionally most abundant species in northeastern Minnesota shifted from the presettlement period (spruce, 21 percent; larch, 15 percent; and paper birch, 15 percent) to aspen (30 percent), spruce (16 percent), and balsam fir (16 percent) in 1990. White pine declined from 20 percent to 5 percent basal area dominance, birch from 16 percent to 13 percent, spruce from 14 percent to 9 percent, and larch from 12 percent to 2 percent, while aspen increased from 8 percent to 35 percent basal area dominance.

In 2015, the SNF estimated that there were approximately 759,700 acres (60 percent of lynx habitat on the SNF) of suitable snowshoe hare habitat on the SNF and that only 23,800 acres of habitat on the SNF was in a condition unsuitable to lynx (USFS 2016, unpublished data).

The SNF continues to manage in accordance with its 2004 Forest Land and Resource Management Plan (USFS 2004a, entire). The Forest Plan emphasizes providing sustainable amounts of timber, maintaining or enhancing biodiversity, contributing to economic and social needs of the community, and managing in an environmentally sound manner to produce goods and services that provide for long-term public benefits. The Forest Plan includes many objectives, standards, and guidelines for the protection of lynx and enhancement of lynx habitat (USFS 2004a, Appendix E, pp. E-1 – E-12) that are based on recommendations in the 2000 LCAS (Ruediger *et al*. 2000, entire). LAUs were delineated on the SNF in 2000 as the smallest landscape scale on which to analyze effects to lynx. The boundaries have remained in place since that time to allow for long term analysis of project effects. However, the SNF Plan proposed several changes of current LAU boundaries, such as adding LAUs to the Virginia Management Unit of the Laurentian Ranger District, and designating the BWCAW a lynx refugium.

This unit is directly connected to lynx habitats and populations in southern Ontario, where trapping of lynx is legal. Habitat connectivity within and between portions of northeastern Minnesota and Canada appears functional based on radio-telemetry data that have documented lynx movements between Minnesota and Ontario (Burdett *et al.* 2007, p. 458; Moen 2009, pp. 4-6; Moen *et al.* 2010b, p. 5).

Lynx Status: At the time of listing, the Minnesota population was not believed to contribute significantly to the DPS. However, we now know that a reproducing resident population exists in northeastern Minnesota. Moen (*in* Lynx SSA Team 2016) recently estimated the potential for a

population of about 50 to 200 lynx to occur in northeastern Minnesota. In 2008, Moen *et al.* (2008b, p. 30), estimated the number of lynx that might be resident in northeastern Minnesota at a given time as between 190 and 250 individuals, assuming that about 25 percent of northeast Minnesota is suitable lynx habitat, coupled with assumptions about residence time and detectability. The actual number of lynx is unknown because methods have not been implemented to measure and produce precise population estimates over such a large geographic area. We have no estimates of lynx densities in Minnesota.

Average home range sizes in Minnesota were reported as 194 km^2 (75 mi^2) for males and 87 km^2 (34 mi^2) for females (Mech 1980, p.263). Later radio-telemetry data showed that males had much larger average home range sizes (267 km^2 [103 mi^2]) than females (21 km^2 [8 mi^2]), and that females with kittens had the smallest home ranges (Burdett *et al.* 2007, pp. 460-461). A study of radio-collared lynx in Minnesota documented approximately 40 percent of male and female lynx making long distance movements outside of their home ranges and into southern Ontario, Canada (Moen *et al.* 2010b, p. 17). Among lynx that made long-distance movements, females tended to move 100-200 km (62-124 mi) and did not return to their original home ranges in Minnesota, while males moved 50-80 km (31-49 mi) back and forth between Ontario and Minnesota (Moen *et al.* 2010b, p. 17). While topographic features may influence lynx movements in mountainous western states, lynx in Minnesota tended to move along nearly straight paths (Moen *et al.* 2010b, p. 13).

The SNF and others have identified 268 unique individual lynx (48 percent Female, 51 percent Male) from DNA samples taken since 2000 (Catton *et al.* 2015, p. 1). Of the 1,306 DNA samples, 1,039 were identified as lynx; however, 42 samples were identified as F1 lynx-bobcat hybrids (Catton *et al.* 2015, p. 1). Of those 42 hybrids, 13 unique individual lynx-bobcat genotypes (5 Female, 8 Male) were also identified (Catton *et al.* 2015, p. 1). The DNA analyses also showed persistence of individual lynx in Minnesota of 2 years (N = 27 lynx), 3 years (N = 11), 4 years (N = 5), 5 years (N = 6), and 1 female lynx tracked for over 5 years, who produced 7 kittens in Minnesota (Catton *et al.* 2015, pp. 3-5).

Since 2000, the Service has documented 45 lynx mortalities in Minnesota including 16 that died of unknown causes, 11 that died after being incidentally captured in traps set for other species, nine that were hit by vehicles on roads, seven that were illegally shot, and two that were hit by trains (USFWS 2016, *unpublished data*). In addition to the 11 trapping mortalities, another 15 lynx were documented to have been incidentally trapped but released alive. The documented incidents largely occurred during legal trapping that targeted bobcat, coyote, fox, and marten, and involved a variety of traps including foot-holds, body gripping traps, and snares. It is probable that other lynx were incidentally trapped but not reported each year (Moen 2009, p. X). Additionally, lynx emigrating from Minnesota to Ontario are exposed to legal trapping and shooting in accordance with regulated harvest in Canada. At least a third of lynx radio-collared in Minnesota spent time in Ontario; 4 radio-collared lynx were legally harvested (trapped) in Canada between 2003 and 2010, and two died in Ontario of unknown causes (USFWS 2016, *unpublished data*). Minnesota has relatively high forest road and highway densities that

intersect lynx habitat and several radio-collared lynx in Minnesota inhabited home ranges that were bisected by highways.

Factors Affecting Current Conditions

Identified factors affecting to the current conditions of lynx in Minnesota include reduction in habitat quality or quantity, habitat fragmentation, climate change, increased access for competing carnivores, and human-caused mortality. The SNF is currently implementing the 2004 SNF Plan (USFS 2004a, entire), which has direction based on the LCAS (Ruediger et al. 2000, entire) and the Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (USFS and USFWS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can produce lynx habitat, and the SNF has a long-term commitment for doing so; however, private landowners do not. Under the Sustainable Forest Resource Act of 1995, the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2012, p. 1) - these voluntary guidelines are intended for private and State landowners and include some general recommendations for wildlife including lynx. The implementation of the MFRC guidelines is monitored annually (e.g., MDNR 2015, entire). Thus, the several risk factors are being minimized and managed to promote the conservation of lynx within the SNF, however implementation of the guidelines on privately owned lands is voluntary.

Activities that change forest structure can affect habitat quantity and quality for lynx and snowshoe hares, their primary prey source. Thinning and other timber management practices that reduce stem density and downed material and promote more open, mature stands can reduce habitat quality and quantity. Throughout the SNF and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Mineral exploration and development is increasing in portions of Minnesota, particularly for hard rock (non-ferrous) minerals. Some of the area of interest for minerals overlaps with lynx habitat in northeastern Minnesota. Mineral exploration may result in short-term displacement of lynx. Mining activities and associated development may result in an irreversible loss of habitat or increased mortality risk. The specific effects to lynx and their habitat will depend on the scale and type of each project.

Roads are a factor in human-caused lynx mortality where they provide access to areas where lynx occur, increasing the risk of negative interactions between people and lynx. Throughout the SNF outside the BWCAW, high and low standard roads bisect many areas that provide potential or suitable lynx habitat. Additionally, bobcat harvest in northeastern Minnesota has been increasing over the last decade (Erb 2012, unpaginated). Where lynx and bobcat overlap, there is potential for accidental shooting of lynx, or for bobcat hunting with dogs to harass or harm lynx.

Snow compacts under natural conditions; however, snow compacted by human activity may increase access by coyotes and bobcats to prey in deep snow conditions where historically they

were excluded or rare. Winter road use, snowmobiling, cross country skiing, and dog sledding all may increase the amount and distribution of compacted snow conditions. Outside the BWCAW, snowmobile activity is extensive and increasing significantly. The SNF has 705 miles of snowmobile trails and 1,562 miles on all ownerships within the proclamation boundary (USFS 2011, p. 38). Advances in snowmobile capabilities have raised concerns about intrusion and new snow compaction in areas previously not vulnerable to high levels of snowmobile use. In addition, new road construction in lynx habitat has made more areas accessible during winter. These routes could be used by snowmobiles even if new roads are designated as closed to motorized public travel during other seasons. The SNF has 1,927 miles of low standard roads (OML 1 and 2) and 158 miles of temporary roads (USFS 2011, p. 38). All of these factors have potential to reduce the deep and fluffy winter snow conditions and to reduce the competitive advantage of lynx in areas that typically receive deep snows.

As described in Chapter 2, above, lynx are adapted for surviving in areas that have cold winters with deep, fluffy snow, where they outcompete potential competitors such as bobcats, coyotes, and wolves (Buskirk *et al.* 2000a, pp. 90-91; McCord & Cardoza. 1982, pp. 748-749; Ruediger *et al.* 2000, pp. 445-449). The geographical distribution of bobcat harvest in Minnesota has remained relatively static with a lack of harvest in the Arrowhead Region of Minnesota (the region encompassed by Cook, Lake, and St. Louis counties in northeastern Minnesota; Erb 2009 cited in Kapfer 2012, p. 16; Erb 2012, unpaginated) and annual snow track and scent stations surveys support the conclusion that bobcats are as rare in the Arrowhead Region as harvest indicates (MN DNR unpublished data cited in Kapfer 2012, p. 23). However, this may change with decreased snow conditions predicted to result from continued climate warming (Kapfer 2012, p. 25). Bobcat and coyote populations already appear to be increasing in Minnesota (Erb 2014, p. 40). If snow depth and duration decrease in the Arrowhead Region, deer mortality may be reduced; this may potentially increase bobcat densities and facilitate bobcat expansion into northeastern Minnesota (Kapfer 2012, p. 25). According to annual track surveys, wolf populations in Minnesota are currently stable (Erb 2014, p. 40); however, similar to bobcat, wolf populations may increase with changing snow conditions and prey availability as influenced by climate change.

Furthermore, in Northeastern Minnesota, several lynx-bobcat hybrids have been documented (Catton *et al.* 2015, p. 1), however, most bobcat records occur south and west of the core part of the lynx range in Minnesota (see figure 1.1 *in* Kapfer 2012, p. 51). Bobcat populations are increasing in Minnesota (Erb 2014, p. 40) and more bobcat-lynx hybridization may occur as a result of climate change (Koen *et al.* 2014b, p. 113).

4.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Unit Description: This geographic unit includes the parts of northwestern Montana and northeastern Idaho the Service designated as critical habitat (Unit 3) for lynx in 2014 and some Tribal and State lands that were excluded from that designation (79 FR 54825). It encompasses approximately 27,000 km^2 (10,424 mi^2) in portions of Boundary County in Idaho and Flathead, Glacier, Granite, Lake, Lewis and Clark, Lincoln, Missoula, Pondera, Powell and Teton Counties

in Montana, with ownership that is 84 percent Federal (USFS,NPS, and BLM); 8 percent private; 4 percent State; and 4 percent Tribal. Most Federal lands in this unit (82 percent) are on national forests managed by the USFS; with NPS (16 percent) and BLM (almost 2 percent) contributing most of the remainder. This unit includes most of Glacier National Park and parts of the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests, the BLM's Garnet Resource Area, and the Confederated Salish and Kootenai Tribes Flathead Reservation. It also includes (from northwest to southeast) all or parts of the Purcell, Cabinet, Salish, Whitefish, Lewis, Flathead, Swan, and Garnet mountain ranges. Several areas adjacent to this unit are known or thought to support a small number of resident lynx, at least intermittently, including the southern Selkirk Mountains of northern Idaho and northeastern Washington and the western Cabinet Mountains of northern Idaho (B. Holt 2016, *pers. comm.*; USFS 2015, pp. 9-10), and a small area of the Helena National Forest just south of MacDonald Pass, between Helena and Missoula (Gehman *et al.* 2011, p. 21). This unit is directly connected to lynx habitats and populations in Canada, and lynx in this unit may represent the southern extent of a larger cross-border population that also occurs in southwestern Alberta and southeastern British Columbia (B.C.). Relative to other DPS lynx populations, this unit is about 200 km (125 mi) east of the north-central Washington unit, about 145 km (90 mi) northwest of the GYA, and about 1,480 km (920 mi) west of the Northeastern Minnesota geographic unit.

Habitat Description: In the Northern Rocky Mountains, most lynx occurrences are associated with the Rocky Mountain Conifer Forest or Western Spruce-Fir Forest vegetative classes (Kuchler 1964, p. 4; McKelvey *et al.* 2000a, p. 246) at elevations ranging from 1,250 m (4,100 ft) to 2,500 m (8,200 ft) (Aubry *et al.* 2000, pp. 378–380; McKelvey *et al.* 2000a, pp. 243–245). The dominant vegetation that constitutes lynx habitat in these areas is subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanii*) and lodgepole pine (*Pinus contorta*) (Aubry *et al.* 2000, p. 379; Ruediger *et al.* 2000, pp. 4-8 - 4-10). Within these vegetation types, lynx appear to prefer areas of moderate to gentle topographic relief (Koehler and Aubry 1994, p. 86; Apps 2000, p. 352; Squires *et al.* 2013, pp. 187, 191). Lynx use large landscapes that include a temporally- and spatially-shifting mosaic of forest age classes, where natural or anthropogenic disturbances may reset forest succession (ILBT 2013, p. 28). Early successional stages that often provide dense horizontal cover at ground/snow level and support high hare densities (Griffin 2004, pp. 53-54, 70; Squires *et al.* 2010, pp. 1654-1656) may be created and maintained by natural disturbance processes including wildfire, insect infestations, tree diseases, and wind events (ILBT 2013, p. 28). Timber harvest, other silvicultural treatments, wildfire management, or other vegetation management, which may be beneficial, benign, or adverse to lynx and hare habitats depending on prescription, extent, and implementation, can also influence the amount and distribution of early successional stands (Agee 2000, p. 39; ILBT 2013, pp. 28, 71-76). Likewise, natural disturbance regimes and forest management can also influence the amount and distribution of mature multistoried spruce-fir stands, which can include dense horizontal structure, support high hare densities (Griffin 2004, pp. 53-54, 70; Squires and Ruggiero 2007, pp. 313-314; Berg *et al.* 2012, pp. 1483-1485), and provide preferred winter foraging habitat for lynx (Squires *et al.* 2010, pp. 1653-1657).

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In northwestern Montana, lynx generally occur in mid-elevation (1,260 – 2,355 m [4,130 – 7,730 ft]) moist subalpine mixed-conifer forests dominated by Englemann spruce and subalpine fir and including Douglas fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and lodgepole pine (Squires *et al.* 2010, pp. 1653-1654). Lynx home ranges occur in areas with low surface roughness (i.e., low topographic relief; gently-sloping to moderately-steep terrain), high canopy cover indices, and little open grassland (Squires *et al.* 2013, p. 191). These lynx habitats occur below the alpine zone and above drier, more open forest types (e.g., ponderosa pine [*Pinus ponderosa*] and dry Douglas-fir/western larch/lodgepole pine) that do not provide lynx habitat (Agee 2000, p. 42; Berg 2009, p. 20; Squires *et al.* 2010, p. 1655). As elsewhere in the western portion of the DPS, this elevational pattern contributes, along with the transition from boreal to more temperate forests, to a naturally patchier, more fragmented distribution of lynx habitat than in the continuous boreal forest landscape in the core of the lynx's North American range in northern Canada and interior Alaska (65 FR 16052-53; 68 FR 40089; Squires *et al.* 2006[a], pp. 46-47; ILBT 2013, pp. 76-77; Squires *et al.* 2013, p. 191; 78 FR 59438). Squires *et al.* (2013, pp. 187-189) used telemetry data to model the distribution of probable lynx habitat in a 36,096-km^2 (13,937-mi^2) study area that completely overlaps this geographic unit. Their results indicate that much of the area has a low to moderate probability of selection by lynx, and that the areas with higher selection probabilities are relatively small and patchily- but widely- distributed throughout the unit and are separated by intervening areas of low probability of lynx use (Squires *et al.* 2013; see Figure 1(a), p. 189). This patchy distribution of high-quality habitats interspersed with areas of low-quality or non-habitat results in naturally lower densities of both snowshoe hares and lynx than those in the continuous boreal forests of northern Canada and Alaska (Wolff 1980, pp. 123–128; Buehler and Keith 1982, pp. 24, 28; Koehler 1990, p. 849; Koehler and Aubry 1994, p. 84; Aubry *et al.* 2000, pp. 373–375, 382, 394).

In winter in this unit, lynx preferentially use mature multistoried forest stands, predominantly spruce-fir, with dense horizontal cover, and they avoid clearcuts and large forest openings (Squires *et al.* 2010, pp. 1648, 1653–1656). In summer, lynx also select young stands with dense spruce-fir saplings, do not appear to avoid openings as in winter, and use slightly higher elevations (Ibid.). Both mature multistoried and young regenerating stands provide dense horizontal structure at ground/snow level, which supports higher snowshoe hare densities than more open young or mature forests. In the central (Seeley Lake study area) part of this unit, during an apparent regional hare decline in 1999-2001, summer hare densities were highest (up to 1.4 hares/ha in one study area) in dense young stands, and winter densities were highest (up to 1.8 hares/ha in one study area) in dense mature stands (Griffin and Mills 2009, pp. 1492-1496). Over a longer interval (1999-2003) when hare populations in this area were thought to be stable (Squires and Ruggiero 2007, p. 314), mean summer and winter hare densities, respectively, were 0.34 hares/hectare (ha) and 0.53/ha in dense mature stands and 0.64/ha and 0.47/ha in dense young stands – habitats selected by lynx, compared to 0.18/ha and 0.20/ha in open mature stands and 0.18/ha and 0.12/ha in open young stands that lynx did not select (Squires and Ruggiero 2007, pp. 313-314). Even the relatively higher hare densities in the dense mature and dense young stands only marginally achieve the threshold density of 0.5/ha thought necessary to support lynx within home ranges (Ruggiero *et al.* 2000b, pp. 446–447; ILBT 2013, pp. 24, 26, 90). Nonetheless, hares accounted for 96 percent of the biomass in lynx

diets in this unit based on evidence at kill sites (Squires and Ruggiero 2007, pp. 310-313), suggesting that even small declines in landscape-level hare densities could reduce the ability of habitats in this unit to support resident lynx (Squires *et al.* 2010, p. 1656).

Lynx in this unit generally den in mature spruce-fir forests among downed logs or root wads of wind-thrown trees in areas with abundant coarse woody debris and dense understories with high horizontal cover in the immediate areas around dens (Squires *et al.* 2004a, Table 3; Squires *et al.* 2008, pp. 1497, 1501–1505). Few dens are located in young regenerating or thinned stands with discontinuous canopies (Squires *et al.* 2008, p. 1497). Many dens have northeasterly aspects and are farther from forest edges than random expectation (Squires *et al.* 2008, p. 1497).

Average annual snowfall in this unit ranges from about 142 cm (56 in) in the Kalispell/ Whitefish/ West Glacier area of northwestern Montana to 183 cm (72 in) in Nordman in northern Idaho, to 216 cm (85 in) in Lincoln, Montana, near the southern end of the unit, to 259 cm (102 in) in Rexford, Montana near the Canada - U.S. border, to 345 cm (136 in) in Seeley Lake, Montana, in the central part of the unit, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 4/2/2016).

Habitat Status: Lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 84 percent (22,761 km^2 [8,788 mi^2]) of this unit is in Federal ownership, including 18,695 km^2 (7,218 mi^2) in national forests under USFS management, 3,658 km^2 (1,412 mi^2) in Glacier National Park managed by NPS, and 397 km^2 (153 mi^2) managed by BLM in its Garnet Resource Area. As described above, potential lynx habitat in this unit is patchily- distributed and interspersed with areas of non-habitat (matrix). Among the six national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 54 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123). In Glacier National Park, 2,976 km^2 (1,149 mi^2; about 73 percent of the park) is considered “lynx forest types” (65 FR 16073), but only 1,103 km^2 (426 mi^2; 27 percent of the park, 37 percent of lynx forest types) is estimated to be lynx habitat (68 FR 40086, 40089). In the Garnet Resource Area, the BLM designated five LAUs (which approximate a lynx home range) covering 947 km^2 (366 mi^2), of which, 574 km^2 (222 mi^2; about 61 percent) was mapped as lynx habitat (Sparks 2016a, *pers. comm.*).

Federal lands are managed as either ‘‘developmental’’ or ‘‘nondevelopmental’’ land use allocations (68 FR 40093). Lands in developmental allocations are managed for multiple uses, such as recreation and timber harvest, some of which may conflict with lynx conservation. Management within non-developmental allocations focuses on the maintenance of natural ecological processes, or conservation of rare ecological settings or components, and these areas include wilderness, roadless, and semi-primitive non-motorized areas (USFWS 2007, pp. 33, 77). Timber harvest, road construction, and fire suppression typically do not occur or are very limited in lands managed in non-developmental allocations.

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In this SSA unit, almost 46 percent of the Federal land and 40 percent of the entire unit is in designated wilderness or national park land, including (in addition to Glacier National Park) the 6,297-km^2 (2,431-mi^2) Bob Marshall Wilderness Complex (Bob Marshall, Great Bear, and Scapegoat wilderness areas) on the Flathead, Lewis and Clark, Helena and Lolo national forests, the 302-km^2 (117-mi^2) Mission Mountain Wilderness on the Flathead National Forest, the 139-km^2 (54-mi^2) Rattlesnake Wilderness Area on the Lolo National Forest, and the 371-km^2 (143-mi^2) Mission Mountain Tribal Wilderness on the Flathead Reservation. Management of NPS lands and both national forest and Tribal wilderness areas provides restrictions on land use beneficial to lynx (65 FR 16073; USFWS 2014, pp. 28-29; 79 FR 54831), and adverse effects of management activities on lynx habitats in these areas are unlikely. Among the six national forests that contribute to this unit, 56 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34).

Much of the remaining USFS lands and the BLM lands have developmental land-use allocations where some management activities have the potential to impact lynx or its habitat. However, as described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2004 amended the Resource Management Plan (RMP) for the Garnet Resource Area to incorporate the conservation measures identified in the LCAS (BLM 2004a, 2004b, entire; Sparks 2016b, *pers. comm.*). Both documents provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently- applied framework for conserving and restoring important hare and lynx habitats.

Habitat status on private lands, which account for about 8 percent of lands in this unit (2,172 km^2 [839 mi^2]), is governed by some Federal and State regulations and by a number of private-public conservations partnerships and State agency efforts. As described in section 3.1., above, some Federal and State regulations guide some activities on private lands, including the ESA's prohibition on take of listed species, and State regulations governing trapping and timber management. In addition to these protections, there have been several other notable lynx conservation achievements on private lands in this unit since the DPS was listed. Two of these, the Clearwater-Blackfoot Project and the Montana Legacy Project, are multi-partner and community efforts led by The Nature Conservancy in Montana to purchase large tracts of private commercial timberlands, conveying some to the State of Montana and the USFS for conservation management, and acquiring conservation easements on others (TNC 2016a, 2016b, 2016c, entire). These land acquisitions have resulted in protection of roughly 673 km^2 (260 mi^2) of important lynx habitat within this SSA unit and another 583 km^2 (225 mi^2) just to the south and west that may occasionally or temporarily support lynx or provide dispersal habitat. Additionally, the MTFWP has acquired fee title or conservation agreements on 3,096 km^2 (1,195 mi^2) of private lands in western Montana, including 162 km^2 (63 mi^2) in designated lynx critical

habitat in this SSA unit, with ongoing efforts on another 106 km^2 (41 mi^2) in the northwest part of the unit (MTFWP 2016, pp. 1, 3).

In addition to the MTFWP's efforts to acquire private lands and protect them through fee title or conservation agreement, the State of Montana has also worked to protect lynx habitat on State-owned lands, which account for about 4 percent of the lands in this unit (1,106 km^2 [427 mi^2]). As described above in section 3.1.2, the MTDNRC worked closely with the Service to develop the *State of Montana Department of Natural Resources and Conservation Forested State Trust Lands Habitat Conservation Plan* (MTDNRC HCP; MTDNRC and USFWS 2010a, 2010b, 2010c, entire); a multi-species HCP that focuses primarily on commercial forest management. The HCP includes a Lynx Conservation Strategy that minimizes impacts of forest management activities on lynx, describes conservation commitments that are based on recent information from lynx research in Montana, and commits to active lynx monitoring and adaptive management programs. The HCP covers about 2,220 km^2 (857 mi^2) of forested State trust lands in western Montana, including 703 km^2 (271 mi^2) within this SSA geographic unit (about 64 percent of State lands in this unit). The goal of the HCP's Lynx Conservation Strategy is to support Federal lynx conservation efforts by managing for habitat elements important to lynx and their prey that contribute to the landscape-scale occurrence of lynx. Specific objectives to achieve this goal include protecting den sites and potential denning habitat, mapping and maintaining lynx foraging habitats and limiting the spatial and temporal scope of their conversion to unsuitable conditions from forest management activities, and providing for habitat connectivity (MTDNRC and USFWS 2010b, pp. 2-45 - 2-61). The HCP was finalized and permitted by the Service in 2011, and includes a 50-year commitment by the State to manage for lynx conservation on these lands (79 FR 54835-37).

Tribal lands of the Flathead Reservation account for almost 4 percent of this unit. In addition to the Tribe's approach to lynx management described in section 3.2.1, above, most lynx and lynx habitat on the reservation occur in areas with formal protective status, including: (1) The long-designated Mission Mountains and Rattlesnake Tribal Wilderness Areas, which are largely roadless and managed for wilderness qualities; (2) the South Fork/Jocko Primitive Area, which is open to use only by Tribe members and in which commercial timber harvest is prohibited; and (3) the Nine-mile Divide country, which is marginal in terms of lynx habitat, but which is also partly roadless (Courville 2014, *pers. comm.*; 79 FR 54831).

As elsewhere in the DPS, winter foraging habitat is thought to be the most limiting habitat for lynx in this unit (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27). As described above, lynx selected mature multistoried stands with dense horizontal structure and relatively higher winter hare densities (Squires *et al.* 2010, pp. 1648, 1653–1656). Because of this preference, the Forest Service in the NRLMD adopted a vegetation management standard (VEG S6) that precludes all vegetation management activities that could reduce winter snowshoe hare habitat in multistoried forests, not just precommercial thinning as recommended in the LCAS (USFS 2007, pp. 13-14). Also as elsewhere (Moen *et al.* 2008a, p. 1512; Organ *et al.* 2008, pp. 1514, 1516–1517, ILBT 2013, p. 30; 79 FR 54790), denning habitat is not thought to be a limiting factor for lynx in this unit (Squires *et al.* 2008, p. 1505). Nonetheless, the NRLMD includes

guidance to ensure adequate denning habitat remains well distributed in LAUs and, therefore, across the larger landscape and to design projects to create or retain coarse woody debris in areas where denning habitat may be lacking (USFS 2007, p. 17). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America, showing that this geographic unit currently has a 90-95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

Overall, although naturally fragmented and patchily-distributed, lynx habitat in this geographic unit appears to be largely intact relative to historical conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway) development and evidence of minor genetic differentiation among lynx subpopulations (see *Lynx Status*, below), past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

A possible exception may be in the Garnet Mountains, which are known to have supported a small number of resident lynx in the 1980s and recently from 2002-2010, but where more recent surveys and research trapping efforts have failed to detect lynx (Squires *in* Lynx SSA Team 2016, p. 20; also see Lynx Status, below). This small and relatively isolated island of lynx habitat (Squires 2014, p. 4) at the southern end of this unit is thought to be capable of supporting 7-10 lynx home ranges (Squires 2016, *pers. comm.*). The BLM (2004, pp. 4-5) contrasted current and historical distributions of lynx habitats in the Garnets and found that early- successional stands (future hare and lynx foraging habitats) were at 25-50 percent of the historical condition in lower- elevation (1,370-1,830 m [4,500-6,000 ft]) lynx habitats, and 10-30 percent in higher- elevation (1,675-2,130 m [5,500-7,000 ft]) habitats. Late- successional (mature multistoried) stands (25-75 percent of historical condition) and large (> 100 ha [250 ac]) patches (25-50 percent of historical condition) were also underrepresented at lower elevations, but at higher elevations, late- successional stands and large patches exceeded 200 percent and 100 percent of historical conditions, respectively. Lower elevation habitats were fragmented by roads and past management practices (i.e., timber harvest), while higher-elevation habitat patterns were attributed to the absence of disturbance, including fire (BLM 2004, p. 5), though fire absence was not attributed to suppression.

As discussed for the GYA in section 2.3.2.2, above, whether the recent absence of lynx in the Garnets represents the extirpation of a previously- persistent small resident population (and, therefore, a contraction in the range of resident lynx in this unit) or a temporary “winking off” of a small peripheral population that would be expected in a mainland-island metapopulation structure is uncertain and perhaps irresolvable. If residency was intermittent or ephemeral historically, the current absence of lynx might be a natural condition related to the area’s

naturally fragmented habitats and generally low hare densities - i.e., it may naturally be capable of supporting resident lynx only intermittently when habitat conditions and hare densities are optimal. If so, future intermittent lynx occupancy would be expected, but only if lynx dispersing from a source population immigrate to the Garnets when habitat conditions and hare densities return to more favorable levels. Conversely, if the Garnets historically supported a small but persistent population that was recently extirpated, it may suggest that the alteration of the historical distribution of some habitats in some parts of the range, described above, was enough to tip the quality of the area's habitat from capable of supporting a small resident population to no longer capable of doing so.

In summary, almost all lands in this unit are managed to conserve lynx and hare habitats in accordance with Federal, State, and Tribal regulations and management direction, conservation easements, and an approved HCP. Much of the area consists of designated Federal and Tribal wilderness areas and other nondevelopmental land use allocations, where management activities with the potential to adversely affect lynx generally do not occur. On lands with development allocations, USFS, BLM, and State management are based on plans that incorporate the conservation guidance identified in the LCAS as informed by more recently-available scientific information. The State and TNC, working with other conservation partners, have bought or acquired conservation easements on large tracts of high-quality private lands in the unit that are known or suspected to be occupied by resident lynx. These efforts and management across multiple ownerships likely preclude landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places, as described above for the Garnet Mountains. Because lynx habitats in this unit, like most other areas of the DPS range, are naturally highly-fragmented, and most have hare densities that barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historical or current number of resident lynx in this unit although, as described in section 2.3.2.2 above, it is thought to be capable of supporting perhaps 200-300 lynx (Squires *in* Lynx SSA Team 2016, p. 41). This is substantially fewer than previous estimates of more than 1,000 lynx, which were based on a habitat area/ density index and broad assumptions regarding habitat suitability and lynx distribution (65 FR 16058) that are not supported by current understanding of lynx habitat requirements. As described above, habitats capable of supporting resident lynx in this unit are naturally patchier and less-broadly distributed (Squires *et al.* 2006a, pp. 46-47; Squires *et al.* 2013, p. 191), and lynx therefore naturally rarer, than was thought at the time of listing (ILBT 2013, p. 23; Jackson *in* Lynx SSA Team 2016, p. 12). Although the exact distribution of resident lynx remains uncertain, this unit has a long and continuous history of lynx occurrence and evidence of reproduction (McKelvey *et al.* 2000a, pp. 224-225; Squires and Laurion 2000, pp. 346-348; Squires *et al.* 2008, entire; Squires *et al.* 2013, entire; ILBT 2013, p. 57; 65 FR 16058; 68 FR 40090; 74 FR 8643; 79 FR 54825). Genetic analyses revealed minor fine-scale genetic sub-

structuring among lynx subpopulations in the southern (Garnets), central (Seeley Lake), and northern (Purcells) parts of this unit, suggesting limited interaction among lynx in those areas (Schwartz *in* Lynx SSA Team 2016, p. 12 and Appendix 5; Squires *in* Lynx SSA Team 2016, p. 20). Lynx in this unit likely represent the southern periphery of a larger population in southwestern Alberta and southeastern British Columbia, but the extent to which lynx persistence in this area may rely on immigration from Canada is unknown, and there is no indication of substantial immigration (irruptions) of lynx from Canada into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20).

From 1998 to 2007, researchers with the Forest Service's Rocky Mountain Research Station in Missoula trapped and radio-marked 175 lynx in northwestern Montana and collected nearly 170,000 GPS and over 3,000 VHS telemetry locations documenting lynx movements, resource use, survival, and productivity (Squires *in* Lynx SSA Team 2016, p. 20). From 1999-2007, litter sizes averaged 2.24 kittens/litter (N = 33) in the Seeley Lake area and from 2003-2007, 2.95 kittens/litter (N = 22) in the Purcell Mountains. In Seeley Lake, 61 percent of breeding-age females (N = 52) produced kittens; in the Purcells, 83 percent of females (N = 28) produced kittens. Recent research (Kosterman 2014, entire) suggests that the probability that a female produces a litter and initial litter size are correlated positively with mature forest connectivity and negatively with fragmentation in female home ranges (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix A). Annual survival rates for subadult and adult female lynx were 0.52 and 0.75, respectively, in Seeley Lake, and 0.68 and 0.85, respectively, in the Purcells. There was no evidence of cyclicity in these vital rates, and no indication of substantial immigration of lynx into these study areas from Canada. Starvation, predation by mountain lions, and human-caused deaths each accounted for roughly one-third of documented sources of lynx mortality. Population viability analyses yielded population growth rates (λ) of 0.92 for the Seeley Lake area (i.e., declining population trend, 1999-2007) and 1.16 for the Purcells (increasing trend, 2003-2007). However, as described in section 2.2.2, above, estimates of λ in a cyclic Canadian population of lynx ranged from 2.03 (annual doubling) when hares were abundant to 0.10 (order of magnitude decline) after hare populations crashed (Slough and Mowat 1996, p. 952, Table 4), and the natural range in λ that would be expected among peripheral, isolated, or semi-isolated and non-cyclic or weakly-cyclic lynx populations in the DPS versus those that would signal long-term population decline or instability is unknown.

As described above, lynx distribution in this unit may have contracted with the recent apparent disappearance of resident lynx from the Garnet Mountains in the southern part of the unit. Lynx were documented in the Garnets in the 1980s and from 2002-2010, but no lynx were detected during snow-track and camera-trap surveys in winter 2014-2015 (Squires *in* Lynx SSA Team 2016, p. 20 and Appendix 5). This area is thought to have habitat capable of supporting 7-10 lynx home ranges (Squires 2016, *pers. comm.*); 5 lynx were monitored via telemetry in 2002, 3 in 2003-2004, 2 in 2005, and single lynx each year in 2006, 2007, and 2010 (Squires *in* Lynx SSA 2016, Appendix 5 [2015 10 14 - 8, p. 26]). As described in section 2.3.2.2 and above, whether the recent absence of lynx from this part of the unit represents the extirpation of a small but previously persistent population (and, therefore, a permanent contraction of lynx distribution

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in this unit) or the temporary "winking off" of a peripheral subpopulation that may become "winked on" again in the future is unknown and perhaps irresolvable.

Snow-tracking, hair-snare, and camera-trap surveys in other parts of this unit since the DPS was listed continued to detect lynx on the Flathead, Helena, Idaho Panhandle, Kootenai, Lewis and Clark, and Lolo national forests (USFS 2015, pp. 9-27). On the Flathead, the USFS Rocky Mountain Research Station(RMRS) trapped and radio-marked 7 lynx (3 females, 4 males) in the Flathead River watershed from 2010-2015, and surveys detected lynx in several other areas including the Salish Mountains, the area just south of Glacier National Park, and in the vicinity of Hungry Horse Reservoir (USFS 2015, pp. 10-11). The Swan Lake District in the southern part of the Flathead, along with the Seeley Lake District of the Lolo National Forest and the Lincoln District of the Helena National Forest, is part of the 6,070-km^2 (2,344-mi^2) Southwestern Crown of the Continent, which was intensively surveyed from 2012-2014 by the Southwestern Crown Carnivore Monitoring Team (SCCMT 2014, entire). The SCCMT conducted snow track surveys and used hair snares, bait stations, and camera traps to detect lynx in 36 of the 82, 8 x 8 km (5 x 5 mi) grid cells they surveyed (SCCMT 2014, pp. 3, 17-20). The surveys resulted in collection of DNA that allowed identification of 18 individual lynx (5 females, 13 males), 13 of which were new to regional lynx databases (SCCMT 2014, pp. 3, 17-20).

On the Helena National Forest, few lynx have been detected outside the Lincoln District/ Southwest Crown described above. In the south MacDonald Pass area, just south of this SSA unit and south of designated critical habitat, an individual male lynx was verified by DNA evidence over four winters (2007-2011), and an individual female was verified in the same area in the winter of 2008-2009 (Gehman *et al.* 2011, p. 21; USFS 2015, p. 27). Other surveys on the Helena failed to detect lynx in the disjunct Big Belt and Elkhorn Mountains, although telemetry data indicated that three lynx released in Colorado passed through the Big Belts in 2004-2006 (USFS 2015, pp. 26-27). Likewise, during snow tracking surveys on the Lolo in 2010-2011 (prior to the Southwestern Crown monitoring described above), lynx were also confirmed on the Seeley Lake District in the eastern part of the forest, but no lynx were documented on the Missoula or Ninemile districts, nor on the Superior and Plains/Thompson Falls districts in the western part of the forest (USFS 2015, pp. 12-14). The USFS concluded that lynx presence in districts other than Seeley Lake is extremely rare and likely represents occasional dispersing lynx (USFS 2015, p. 21).

On the Kootenai National Forest, RMRS research efforts continued to document the long-term presence of lynx, where trapping and radio-marking efforts yielded 50,000-60,000 lynx telemetry locations from 2003-2012 (USFS 2015, p. 10). On the Lewis and Clark National Forest, lynx are considered "still present" in the Rocky Mountain Front portion of the forest, which is within this geographic unit and designated critical habitat, and snow track surveys from 2010-2013 in the disjunct Little Belt and Crazy Mountains documented the continued absence of resident lynx in those ranges (USFS 2015, pp. 25, 27-34). On the Idaho Panhandle National Forest, surveys detected individual lynx in the Selkirk Mountains in 2010 and 2011 and in the Purcell Mountains in 2012. All detections were within 15 miles of the Canada-U.S. border (USFS 2015, p. 10). No lynx were detected during surveys in 2007 or 2013-2014, and snow surveys were not done in

2015 because of poor snow conditions (USFS 2015, p. 9). However, in 2012-2014 three lynx were incidentally trapped on the Idaho Panhandle (one in 2012 in the Purcells, and two in 2014 in the Cabinet Mountains), and another was documented by a Service grizzly bear trapping crew in the Purcells in 2014 (USFS 2015, pp. 9-10; U.S. District Court ID 2016, pp. 6-7).

In summary, although the number of lynx in this geographic unit is uncertain, resident lynx appear to remain broadly distributed throughout most of the unit. The recent apparent absence of lynx in Garnet Mountains may indicate extirpation of a small resident population and a contraction in lynx distribution in the southern part of the unit, or it may reflect natural source-sink dynamics of a naturally ephemeral peripheral population in a mainland-island metapopulation structure. Lynx are rarely detected on surveys on other national forests (or parts of those above) that are outside but adjacent to this geographic unit (Patton 2006, entire; USFS 2105, pp. 1-9, 25-34), suggesting that these areas lack the habitat features and/or landscape-level hare densities necessary to support resident lynx populations (79 FR 54818-54820).

Factors Affecting Current Conditions

Regulatory Mechanisms - Federal management activities (especially timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current Federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on Federal lands and impacts appear to have been localized, they were deemed a low-level threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past Federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. For example, as described above in *Habitat Status* and *Lynx Status*, past timber harvest/management and associated road construction may have fragmented, reduced the amount, and altered the distribution of lynx habitats in the Garnet Mountains, perhaps contributing to the apparent recent loss of that area's ability to support resident lynx.

Currently, as described above and in section 3.1, all Federal and Tribal lands, most State lands, and large blocks of private or formerly-private land in this unit are managed for the conservation of lynx habitats, and much of the unit is in designated wilderness or other nondevelopmental land-use allocations. Regulatory mechanisms and conservation measures associated with these management strategies are intended to conserve and restore lynx and hare habitats across large landscapes and multiple ownerships. Although their effectiveness has not be quantitatively evaluated, and despite the potential extirpation of a small population in the Garnets, lynx habitats and resident lynx appear to remain well distributed throughout most of this unit.

Other regulations prohibit lynx trapping and require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, 16 lynx are documented to have been incidentally trapped in Montana, with 13 of those occurring before 2008, when more protective regulations (e.g., lethal snares prohibited for bobcat sets, leaning pole sets limited to <4" pole and must be 48" above ground for marten,

fisher, and wolverine) were put in place (MTFWP 2016, pp. 5-10). Of the 16, eight were released uninjured, one was released with an injury, and seven were killed; all incidences of mortality occurred prior to 2008 and the implementation of the more protective regulations (MTFWP 2016, p. 5). In Idaho, in addition to the three lynx incidentally trapped on the Idaho Panhandle National Forest from 2012-2014 (described above under *Lynx Status*), one other lynx was incidentally trapped in 2012 on the Salmon-Challis National Forest further south (U.S. District Court ID 2016, p. 6).

Although lynx are legally trapped in Canada adjacent to this unit in southern Alberta and southern British Columbia, trapping there is managed through regulated seasons and harvest levels, which are adjusted to avoid overexploitation, especially during the low phase of the hare-lynx population cycle (Environment Canada 2014, entire; Vashon 2015, pp. 5-6). Lynx harvest in Alberta varied from about 4,000 to 14,000 annually in the late 1970s and early 1980s, but declined to fewer than 2,000 for most years from 1984-2000, and restrictive quotas and season closures were implemented beginning in the late 1980s (Poole and Mowat 2001, pp. 16, 28). Similarly, harvests in British Columbia peaked at over 12,000 in the early 1960s and over 8,000 in the early 1970s, then declined to fewer than 2,000 for most years from the mid-1980s until the year 2000 (Hatler and Beal 2003, p. 2). Whether, and if so to what extent, trapping in Canada may influence lynx dispersal across the border and into this geographic unit is unknown; however, such dispersal was documented historically when harvest levels in Canada were much higher than under current management.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Hall and Fagre 2003, entire; Mote 2003b, entire; Fagre 2005, entire; Knowles *et al.* 2006, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Squires *in* Lynx SSA 2016, p. 20; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.2.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities, even in areas considered high-quality habitat for this DSP unit, often appear to barely meet the 0.5 hares/ha threshold thought necessary to support resident lynx, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. Modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 90-95 percent probability from 1961-1990. (Future conditions

based on this modeling are described in section 5.2.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609). Although insect outbreaks have affected some parts of the DPS, no major outbreaks have been documented in lynx habitats in this unit (Lynx SSA Team 2016, p. 41).

Vegetation Management - As elsewhere in the DPS range, timber harvest and related vegetation management (precommercial thinning and other silvicultural techniques designed to optimize forest products outputs; ILBT 2013, pp. 71-72) are the dominant land uses potentially affecting lynx habitats in this unit (68 FR 40075, 40092; 79 FR 54825). As described in section 3.3, above, these activities can reduce hare and lynx habitats by reducing horizontal cover and altering natural disturbance regimes and forest successional patterns. In this unit, precommercial thinning was shown to reduce short-term hare abundance (Griffin and Mills 2007, entire) and appeared to influence lynx movements (Squires *et al.* 2013, p. 192-194), and lynx rarely traveled across recent clearcuts or other large openings, especially in winter (Squires *et al.* 2010, p. 1654; ILBT 2013, p. 77). However, as described under *Habitat Status*, above, these activities on Federal lands, which account for most of the lands in this unit, occur only on lands with developmental allocations and historically appear to have impacted only a small proportion of potential lynx habitats in this unit (65 FR 16072; 68 FR 40093). Additionally, timber harvest levels on Federal lands in the West, including the Northern Rockies, and specifically with regard to "lynx forest types," had declined consistently and dramatically for a decade or longer prior to the DPS being listed (68 FR 40093), and have remained at levels much lower than those from most of the previous century. Despite some likely localized impacts, past vegetation management does not appear to have broadly diminished this unit's ability to support resident lynx, although, as described above, it may have contributed to the current absence of a small number of resident lynx from the Garnet Mountains. Also as described above, current vegetation management in this unit on all Federal, most State and Tribal, and some private lands, is conducted in accordance with formally amended USFS and BLM management plans, an approved State HCP, Tribal regulations, and conservation easements designed to avoid or minimize impacts to lynx habitats, especially important hare and lynx winter foraging habitats.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, where about 15 percent (4,172 km^2 [1,611 mi^2]) of the unit has burned from 2000-2013 (Squires *in* Lynx SSA Team 2016, p. 20), likely in response to climate warming and related increases in drought conditions (e.g., Harvey *et al.* 2016, entire; Westerling 2016, entire). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction. In the Northern Rocky Mountains, the forests upon which lynx depend have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx (with the possible exception of the Garnet Mountains). Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Idaho (1) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates are unknown. This unit is directly connected to lynx habitats and populations in southwestern Alberta and southeastern British Columbia, where lynx habitats are also (like Montana and Idaho) patchily-distributed and generally support low hare densities, and where some lynx populations may be ephemeral and the persistence of others reliant on periodic influx of immigrants (Apps 2007, pp. 81, 95-104). Additionally, connectivity between this geographic unit and lynx habitats and populations in southern Alberta and southern British Columbia may be facilitated by only a few predicted corridors that extend south from the international border (Squires *et al.* 2013, pp. 187, 191-193).

Although lynx occurrence and harvest records in this geographic unit reflect the unprecedented irruptions of lynx from Canada into the northern contiguous U.S. in the early 1960s and early 1970s (McKelvey *et al.* 2000a, pp. 224-226, 232-242), there is no evidence of irruptions of lynx into this unit after the 1980s (Squires *in* Lynx SSA Team 2016, p. 20). This is supported by lynx trapping records from Canada, which suggest that the magnitude of lynx populations cycles in Alberta and British Columbia dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Poole and Mowat 2001, p. 28; Hatler and Beal 2003, p. 2; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which would be expected to alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit are reliant on immigration from Canada

which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area (λ = 0.92, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. In contrast, the growth rate estimated for the lynx population in the Purcell Mountains in the northwestern part of this unit (λ = 1.16, increasing trend 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) suggests that the level of immigration, if necessary for demographic stability, has been adequate or that productivity and recruitment have been high enough to offset potentially diminished immigration. It is also possible that, despite the documented historical intermittent (cyclic) influxes of lynx from Canada into lynx populations in this geographic unit, immigration does not contribute meaningfully to the demographic stability of these populations. If that is the case, the estimated growth rates suggest that recruitment has failed to offset mortality in the Seeley Lake population but that it has more than done so in the Purcell Mountains population.

4.2.4 Unit 4 - North-central Washington

Unit Description: This geographic unit is located in the northern Cascade Mountain Range of north-central Washington in portions of Chelan and Okanogan Counties and includes mostly Okanogan-Wenatchee National Forest lands as well as BLM lands in the Spokane District that were designated as critical habitat (Unit 4) for lynx in 2014 (79 FR 54825). The unit also includes State Forest lands (portion of the Loomis State Forest) that were excluded from designation as critical habitat (79 FR 54825). It encompasses approximately 5,176 km^2 (1,988 mi^2), with ownership that is 91.5 percent Federal (USFS, BLM), 8.2 percent State, and 0.3 percent private lands; there are no Tribal lands. This area was occupied at the time lynx was listed and is currently occupied by the species. Evidence from recent research and DNA analysis shows lynx distributed within this unit, with breeding being documented. Although researchers have fewer records in the portion of the unit south of Highway 20, this area contains boreal forest habitat and the components essential to the conservation of the lynx. Further, it is contiguous with lynx habitat north of Highway 20, particularly in winter when deep snows close Highway 20. The northern portion of the unit adjacent to the Canada border also appears to support few recent lynx records; however, it is designated wilderness, so access to survey this area is difficult. This northern portion contains extensive boreal forest vegetation types and the components essential to the conservation of the lynx. Additionally, lynx populations exist in British Columbia directly north of this unit.

As it is throughout the range of lynx in the contiguous U.S., maintaining connectivity with Canada is important to lynx populations in northern Washington and the Cascade Mountains. Singleton *et al.* (2002, entire) evaluated landscape permeability for large carnivores in Washington. They reported broad landscape permeability for lynx between the Thompson River watershed in British Columbia and the U.S. portion of the northern Cascades (Singleton *et al.* 2002, p. 46). According to the LCAS, connectivity currently appears functional, as lynx dispersal

from Washington into Canada was recently documented. A male lynx radio-collared in 2008 in the Loomis State Forest remained there until late winter in 2009, when it dispersed north into Canada toward Hope, British Columbia, and then headed north-east toward Kamloops where it appeared to establish a home range just southeast of Kamloops. This individual was later trapped and killed in British Columbia, highlighting the need for cooperation and shared management goals across political boundaries (LCAS 2013, p. 65).

Several areas adjacent to this geographic unit (e.g., Kettle Range, the Wedge, Little Pend Oreille, Selkirk Mountains of northeast Washington) are known or thought to support a small number of lynx, at least intermittently. One of these areas in particular (Kettle Range) contains the second largest block of potential lynx habitat in Washington comprising approximately 987 km^2 (381 mi^2), which is significantly smaller than the North Cascades that supports approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (Stinson 2001, p. 18). Historically, although the Kettle Range supports a fairly small block of lynx habitat (relative to other geographic areas supporting persistent lynx populations), it was considered to be a stronghold for lynx in Washington (Stinson 2001, p. 14). The Kettle Range was suspected to have supported a resident population until about 30 years ago when over-trapping may have resulted in their extirpation from the mountain range (Koehler *et al.* 2008, p.1523). For example, lynx were consistently trapped in the Kettle Range in the 1960s, 1970s, and 1980s. In the Kettle Range, a total of 81 lynx were trapped from 1961 through 1986. One lynx was harvested in 1963, 3 in 1966, 7 in 1967, 2 in 1969, 26 in 1970, 14 in 1976, and 17 in 1977. A single lynx was taken each year in 1980, 1983, 1985, and 1986 (Stinson 2001, p. 63). Prior to 1961, lynx trapping records were not maintained in Washington. Beginning in 1978, trapping seasons in Washington for lynx were reduced to one month. In 1987 a restricted permit system was implemented, and in 1990 a statewide closure on lynx trapping was implemented (USFWS 2008a, p. 2).

Lynx habitat in the Kettle Range is limited in size and potentially capable of supporting only a few lynx. According to Koehler *et al.* (2008, p. 1523), the Kettle Range could support between 10 to 23 lynx based upon a lynx density of 2.3 lynx/100km^2 and 400 km^2 (154 mi^2) to 987 km^2 (381 mi^2) of lynx habitat. It should be noted that the lynx density estimate was derived from research conducted in the Cascade Range within a large area of contiguous, high quality habitat (Koehler 1990, pp. 845, 847). Lynx habitat in the Kettle Range is much smaller and likely more fragmented, and thus may not be capable of supporting a density of 2.3 lynx/100 km^2. The Kettle Range is also somewhat isolated from other lynx habitats in Washington (e.g., the Cascades) and British Columbia. The Kettle Range is separated from the Cascades in Washington by low elevation valleys dominated by shrub-steppe and Douglas-fir and ponderosa pine forests (Koehler *et al.* 2008, p. 1523), and from British Columbia by the Kettle River Valley (Stinson 2001, p. 20) and a major highway corridor with associated fence in British Columbia (Koehler *et al.* 2008, p. 1523). These natural topographic and anthropogenic features may present impediments to lynx movement between the Kettle Range and the Cascades and British Columbia, making natural recolonization of the Kettle Range by lynx difficult. Thus, it may be difficult for lynx to reestablish a persistent and viable resident breeding population in the Kettle Range.

DRAFT

Habitat Description: In the northern Cascades most lynx occurrences are associated with the Rocky Mountain Conifer Forest (Aubry *et al.* 2000, p. 379; McKelvey *et al.* 2000a, p. 246) at elevations between 1,400 m (4,593 ft) and 2,150 m (7,053 ft) (McKelvey *et al.* 2000d, p. 322; Stinson 2001, p. 9). Within this area lynx primarily use forests dominated by Engelmann spruce, subalpine fir, or lodgepole pine on mild to moderate slopes (less than 30 degrees), and avoid Douglas-fir and ponderosa pine forests, forest openings, recently burned areas with sparse canopy and understory cover (less than 10 percent), low elevations [less than 915 m (3,000 ft)], and steep slopes (greater than 30 degrees) (Koehler *et al.* 2008, pp. 1518, 1521; Maletzke 2004, pp. 16-17). Similar to the northern Rocky Mountains, lynx habitat in the Cascades is naturally fragmented (Koehler *et al.* 2008, p. 1523). Disturbance is common in boreal forests, and fires and insect epidemics are major drivers of this disturbance, but other factors including wind and disease also contribute to the process of disturbance (Agee 2000, p. 47). Fire return intervals in the north Cascades ranges between approximately 100 to 250 years (Agee 2000, p. 50).

Snowshoe hares are the primary prey of lynx throughout their range in North America (Mowat *et al.* 2000, p. 267) comprising 35-97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Lynx also consume other prey species, including red squirrels, mice, voles, grouse, ptarmigan, and other species of mammals and birds, especially during summer or when snowshoe hare population densities decline (Mowat *et al.* 2000, pp. 267-268). Koehler (1990, p. 848) found snowshoe hares were the primary prey of lynx in the north Cascades of Washington occurring in 23 of 29 (79 percent) lynx scats examined, but the remains of red squirrels were identified in 7 of the 29 (24 percent) lynx scats, as were the remains of other species including deer and mice. Von Kienast (2003, p. 39), who also conducted a lynx study in the north Cascades of Washington, found snowshoe hares in 87% (40 of 46) of lynx scats, while red squirrels were identified in 28% (13 of 46) of lynx scats.

Results of lynx research in the northern portion of its range suggest that a minimum density of 0.5-1.0 hares/ha (0.2-0.4 hares/ac) is needed to support lynx reproduction, but it is unknown if a similar snowshoe hare density is required to support lynx reproduction in the southern portion of its range (Ruggiero *et al.* 2000b, p. 446). In the northern portion of lynx range (i.e., the taiga) peak snowshoe hare densities regularly exceed 4-6 hares/ha (1.6-2.4 hares/ac), and cycle as low as 0.1-1 hares/ha (0.04-0.4 hares/ac) (Hodges 2000b, pp. 119-120). In the southern portion of lynx range (e.g., the U.S.) snowshoe hare densities are low compared to those in northern regions (Aubry *et al.* 2000, p. 375). Walker (2005, p. 20) estimated an average snowshoe hare density of 0.89 hares/ha (0.36 hares/ac) with a range of 0.03 to 4.85 hares/ha (0.01 to 1.94 hares/ac) in north central Washington (i.e., the Cascades). The Washington Department of Natural Resources (WADNR) found snowshoe hare densities between 0.3 and 0.7 hares/ha (0.1 and 0.3 hares/ac) on the Loomis State Forest (WADNR 2006, p. 87).

Lynx distribution is nearly coincident with the distribution of snowshoe hares (McCord and Cardoza 1982, entire; Bittner and Rongstad 1982, entire), and lynx occupy habitats where snowshoe hares are abundant (Koehler and Aubry 1994, p. 84). Snowshoe hares are limited to

environments with snowy climates (Ruggiero *et al.* 2000b, p. 448). Average annual snowfall is consistent throughout this unit and is approximately 291 cm (114.5 in) (https://snowfall.weatherdb.com/d/a/Washington; accessed 4/27/2016).

Habitat Status: The range of lynx in the contiguous U.S. is broadly delineated by the distribution of the southern extensions of boreal forest. However, the complexities of lynx population dynamics and our incomplete understanding of the limited lynx occurrence data, combined with naturally dynamic habitat, make it difficult to precisely delineate the historical range of lynx in the U.S. (68 FR 40084). McKelvey *et al.* (2000a, pp. 245-246) described the historical range of lynx in the western U.S., encompassing at least 75 percent of lynx occurrences, as associated with the Rocky Mountain Conifer Forest containing the primary vegetation types of Douglas-fir and western spruce/fir forests. These western spruce fir forests represent the southern extension of boreal forests into the U.S. (Agee 2000, pp. 40-42, 46). The amount of boreal forest habitat in the contiguous U.S. has not changed substantially in the past 100 years (68 FR 40085).

However, while the boreal forest may not have changed substantially within the past 100 years (i.e., permanent or long-term reductions in the quantity or size), it is naturally dynamic with fire and insects representing major disturbance processes (Agee 2000, p. 47) that can create areas temporarily unsuitable for lynx through regeneration of forested stands to early successional conditions (Agee 2000, pp. 62-63). In 2001, the Washington Department of Fish and Wildlife (WDFW) estimated there was approximately 8,923 km^2 (3,445 mi^2) of potential lynx habitat within this geographic unit. Several wildfires affected lynx habitat in the north Cascades during the middle 1990s and early 2000s: 1994 Whiteface Burn (1,554 ha (3,840 ac)); 1994 Thunder Mountain Fire (3,686 ha (9,108 ac)); 2001 Thirty-Mile Fire (2,565 ha (6,338 ha)); and 2001 Farewell Fire (32,278 ha (79760 ac)) (Vanbianchi 2015, p. 23). Subsequent to these fires and incorporating new science on lynx habitat use, Koehler *et al.* (2008, pp. 1521-1522) estimated this geographic unit contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on studies conducted from 2002 through 2004. More recent wildfires, including the 2006 Tripod Fire (70,644 ha (175,656 ac)) (Vanbianchi 2015, p.23), have affected approximately 1,000 km^2 (386 mi^2) of lynx habitat within this geographic unit (Lynx SSA Team 2016, p. 21). Cumulatively, over the past 2 decades these wildfires have burned greater than 50 percent of the suitable lynx habitat within this geographic unit (Koehler *et al.* 2008, p. 1523). These acres are expected to regenerate back into suitable lynx habitat, but it may take several decades for this to occur.

Lynx Status: In Washington, there is little information on the status of the lynx population prior to the early 1960s (Stinson 2001, p. 13). From 1960-61 to 1990-91 a total of 234 lynx were harvested in Washington, with the most lynx trapped in Ferry County (35 percent of the 234), followed by Okanogan (23 percent) and Stevens (10 percent) counties (Stinson 2001, p. 13). The WDFW identified six lynx management zones (LMZs) in Washington: Okanogan, Vulcan-Tunk, Kettle Range, The Wedge, Little Pend Oreille, and Salmo-Priest (i.e., essentially the Selkirk Mountain Range in northeast Washington (Stinson 2001, p 14). In 2001, the WDFW considered lynx to be present in the Okanogan, Kettle Range, Little Pend Oreille, and Salmon-Priest LMZs; at that time lynx had not been detected in the Wedge LMZ since 1987 nor the Vulcan-Tunk LMZ since 1990 (Stinson 2001, p.15).

In 2001, based on data collected from lynx telemetry studies conducted in the Cascade Range during the 1980's, the WDFW estimated that Washington contained approximately 12,579 km^2 (4,857 mi^2) of lynx habitat which could theoretically support up to 238 lynx (based on a lynx density of 2.5 lynx/100 km^2) (Koehler 2008, p. 1518; Stinson 2001, p. 16). However, based on professional opinions of individuals knowledgeable about lynx and lynx habitat, the WDFW adjusted this number down suggesting that Washington likely supported fewer than 100 individual lynx (Stinson 2001, p. 16). More recently, Koehler *et al.* (2008, p. 1523), estimated there was approximately 3,800 km^2 (1,467 mi^2) of lynx habitat in Washington potentially supporting up to 87 lynx. This more recent population estimate was based on a study investigating lynx habitat use in the Okanogan from 2002 to 2004, and used a lynx density estimate of 2.3 lynx/100 km^2 derived from a radio-telemetry study conducted on lynx in the Cascades from 1985-1987 (Koehler 1990, pp. 845-847). However, the study area in which the 2.3 lynx/100 km^2 density estimate reported by Koehler (1990, p.847) was derived is located in an area of the northern Cascades known as the "Meadows". During the time of Koehler's (1990, entire) study the Meadows provided some of the best lynx habitat in Washington, whereas most other lynx habitat in Washington is lower in elevation and more highly fragmented (Walker 2005, pp. 3, 6). Thus, the lynx densities Koehler observed in his study area in the Meadows may not translate to lynx densities throughout the rest of lynx habitat in Washington, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines. Thus, applying Koehler's estimated lynx density uniformly throughout Washington, may overestimate the overall lynx population capable of being supported in Washington.

Relative to the Okanogan LMZ (i.e., the north Cascades), which supports the only known persistent breeding population of lynx in Washington State, in 2001, the WDFW estimated the LMZ could support a maximum of 149 lynx (Stinson 2001, p. 16). This number was derived by estimating that the LMZ contains approximately 8,923 km^2 (3,445 mi^2) of lynx habitat (which was decreased by 33 percent to account for unsuitable areas) combined with an average lynx population density estimate of 2.5 lynx/100km^2 derived from two studies conducted in the 1980s (Stinson 2001, p. 16). The estimated quantity of lynx habitat was based on mapping areas supporting the forest-type and physiographic characteristics identified as being used by lynx during telemetry studies conducted in the 1980s (Koehler *et al.* 2008, p. 1518), irrespective of the current condition (successional stage, or stand type, structure, or age, etc.) of the habitat. The estimation of lynx habitat was based purely on forested areas potentially supporting a forest-type potential of subalpine fir/Engelmann spruce, and the physiographic characteristics of elevations greater than 1,400 m (4593 ft) on mild to moderate slopes (Koehler *et al.* 2008, p. 1518), and did not consider whether the area was recently burned, harvested, etc. Recognizing that new information on lynx and snowshoe hare habitat use patterns had been learned since the 1980's, and that several large, stand-replacing fires had burned in lynx habitat, Koehler *et al.* (2008, entire) conducted a lynx telemetry study in the Okanogan from 2002 to 2004 to reassess the suitability of lynx habitat. They estimated that the Cascades contained approximately 2,411 km^2 (930 mi^2) of suitable lynx habitat based on mapping areas supporting Engelmann spruce/subalpine fir forests with moderate canopy cover on flat to moderate slopes at elevations

from 1,525 m (5003 ft) to 1,829 m (6000 ft) (Koehler *et al.* 2008, pp. 1521-1522). Therefore, at that time and using Koehler's (1990, p. 847) lynx density estimate of 2.3 lynx/100 km^2, the Cascades could theoretically support approximately 55 individual lynx.

From 1985 to 1987, the movements of five adult male and two adult female radio-collared lynx were monitored by Koehler (1990, entire) in the Cascades of north-central Washington. During the study two kittens were also captured and ear-tagged (Koehler 1990, p. 847). Results of the study indicated female average home range size was 39 km^2 (15 mi^2) and average male home range size was 69 km^2 (27 mi^2). Based on occupancy of the 640 km^2 study area by 15 adult lynx, adult lynx density was estimated to be 2.3 adults/100 km^2. Annual adult survival rates of the radio-collared lynx were 0.73 in 1986 and 1.00 in 1987, and kitten mortality was high at 88 percent with only 1 of 8 known kittens surviving its first year (Koehler 1990, p. 847).

As stated previously, fire is a common disturbance factor in boreal forests (Agee 2000, p. 47). Fire return intervals within western subalpine fir forests in the Cascades range from 109 to 250 years (Agee, 2000, p. 50) with typically high fire intensities in lynx habitat resulting in extensive areas of regenerating forest (Agee, 2000, p. 53). Maletzke assessed the effects of recent fires in the Cascades and their potential impacts to the lynx population there as follows:

> "From 1990-2002, there were about 2,600 km^2 of lynx habitat in the Okanogan (Eastern Cascades) area, and female home ranges were estimated at 39 – 41 km^2, suggesting the potential to support roughly 90-115 resident females (home ranges include "matrix" or non-habitat). By 2014, habitat had been reduced by fire to about 1,600 km^2, and habitat loss and fragmentation resulted in female home ranges increasing to an estimated 91 km^2, with a potential to support roughly 27 resident females" (Lynx SSA Team 2016, p. 21).

Therefore, using Maletzke's method and assuming a 2:1 sex ratio of females to males, the total theoretical lynx population that may have been supported in the Cascades prior to 2002 may have ranged between 135 and 172 individual lynx. Subsequent to the fires the total theoretical lynx population potentially supported in the Cascades has been reduced to approximately 40 individual lynx, which potentially represents a 70 percent to 77 percent decline in the lynx population. Note: while the area (lynx habitat in the Cascade range) used to generate the population estimate of 55 lynx in the Cascades prior to the fires based on Koehler's (1990, p. 847) lynx density estimate is the same as the area used by Maletzke to generate his population estimate of 90 – 115 resident females based on simulated female home ranges with an empirically derived size and arbitrary minimum threshold of habitat, the two dissimilar population estimates used differing methodologies, and thus the population estimates themselves are not comparable. However, using Koehler's lynx density estimate of 2.3 lynx/100 km^2 and applying it to the 1,600 km^2 of lynx habitat remaining after the fires results in an estimated lynx population of approximately 37 individual lynx, which represents an approximate 33 percent reduction in the lynx population. Further informing the effects of these recent fires in the Cascades on lynx habitat is illustrated by evaluating the average size of a female lynx home range prior to and after the fires. Prior to the fires, Koehler (1990, p. 847) estimated an average female lynx home range size of 39 km^2 (15 mi^2), whereas after the fires Maletzke estimated the average female

home range size had increased to 91 km^2 (35 mi^2) (Lynx Workshop Report 2016, p. 21). The important point is the recent large, stand replacing fires in the Cascades has resulted in significant temporary losses of lynx habitat, and thus the ability of the Cascades to support a persistent and viable reproducing lynx population may have been significantly impacted. The areas impacted by these recent fires are expected to regenerate into suitable lynx habitat, but it may take 35-40 years to do so (Lynx Workshop Report 2016, p. 21).

Factors Affecting Current Condition

In 1993, lynx were classified by the Washington Fish and Wildlife Commission as a State threatened species (Stinson 2001, p. 22). On July 12, 2016, the WDFW recommended that the Washington Fish and Wildlife Commission uplist the lynx from a State threatened to a State endangered species (WDFW 2016, p.1). According to the Draft Washington State Periodic Status Review for the Lynx, the WDFW recommended listing the lynx as endangered because of: 1) observed range contraction in Washington following protection efforts; 2) the substantial loss of habitat in the last 20 years; and 3) the ongoing and anticipated threats to lynx population persistence.

Within Washington, the vast majority of lynx habitat is administered by the Okanogan/ Wenatchee (OWNF) and Colville (CNF) National Forests. The North Cascades (aka the Okanogan LMZ in north-central Washington), which supports the only known, long-term persistent lynx breeding population in Washington, and within which critical habitat was designated for lynx in 2014 (79 FR 54782), is administered by the OWNF. Subsequent to listing lynx under the ESA, the Forest Service entered into a Conservation Agreement (CA) with the Service in 2000 (USFS and USFWS 2000, entire), which was revised and extended in 2006 (USFS and USFWS 2006, entire). The CA committed the ONWF and CNF to use the Lynx Conservation Assessment and Strategy (LCAS) for management of lynx and its habitat on their ownerships, and will remain in place until the forests amend or revise their individual LRMPs.

The LCAS, which was also developed pursuant to the listing by an interagency team comprised of USFS, BLM, Service, and NPS personnel, identified four primary risk factors potentially exerting population level effects upon the status of lynx: climate change, vegetation management, wildland fire management, and habitat fragmentation. To promote conservation of lynx and its habitat, the LCAS contains conservation measures addressing the identification and maintenance of lynx habitat (foraging, denning, and connectivity habitats) on Federal lands. Toward this end, the LCAS recommends that Federal land managers identify and map lynx habitat on their ownerships, and delineate LAUs containing the mapped lynx habitat, within which the effects of management actions on lynx habitat will be monitored and analyzed. The LCAS also recommends that the size of LAUs should be based on the average size of a female lynx home range and contain year-round habitat components (i.e., foraging and denning habitat). Thus, in Washington, and the north Cascades specifically, it appears that the single threat for which lynx were listed under the ESA (i.e., inadequacy of regulatory mechanisms) has largely been addressed through the development of the LCAS, and CA between the Forest Service and Service which commits the Forest Service, specifically for Washington the OWNF

and CNF, to use the LCAS in the management of lynx habitat on their ownerships and when designing and implementing projects within LAUs.

The WADNR manages approximately 4 percent of the lynx habitat within portions of each of the delineated LMZs (WADNR 2006, p.9) in Washington State, including the Loomis State Forest that is located in the north Cascades of north-central Washington within the Okanogan LMZ. In 1996, the WADNR developed and implemented a Lynx Habitat Management Plan (1996 Lynx Plan) in response to listing of the lynx as a State threatened species by Washington State (WADNR 1996, entire). After the DPS was Federally listed as threatened, the WADNR in 2006 modified its Lynx Habitat Management Plan to incorporate new science and management standards and guidelines to avoid the incidental take of lynx in accordance with the ESA (WADNR 2006, entire). These standards and guidelines address maintenance of lynx denning and foraging habitat, as well as habitat connectivity within and between LAUs and lynx populations within Washington (i.e., LMZs) and Canada.

For example, the WADNR 2006 Lynx Plan includes, among other things: (1) Encouraging genetic integrity at the species level by preventing bottlenecks between British Columbia and Washington by limiting size and shape of temporary non-habitat along the border and maintaining major routes of dispersal between British Columbia and Washington; (2) Maintaining connectivity between subpopulations by maintaining dispersal routes between and within zones and arranging timber harvest activities that result in temporary non-habitat patches among watersheds so that connectivity is maintained within each zone; (3) Maintaining the integrity of requisite habitat types within individual home ranges by maintaining connectivity between and integrity within home ranges used by individuals and/or family groups; and (4) Providing a diversity of successional stages within each LAU and connecting denning sites and foraging sites with forested cover without isolating them with open areas by prolonging the persistence of snowshoe hare habitat and retaining coarse woody debris for denning sites. The 2006 Lynx Plan also describes how WADNR will monitor and evaluate the implementation and effectiveness of the plan. The WADNR has been managing for lynx for almost two decades, and the Service has concluded that the management strategies implemented are effective. In the final revised critical habitat designation, published in the Federal Register on February 25, 2009 (74 FR 8657–8658), we determined that the benefits of excluding lands managed in accordance with the WADNR 2006 Lynx Plan outweighed the benefits of including them in the designation, and that doing so would not result in extinction of the species. We, therefore, again are considering excluding 164.2 mi^2 of lands managed in accordance with the WADNR 2006 Lynx Plan from the revised lynx critical habitat designation.

Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within the north Cascades (Koehler *et al.* 2008, p. 1523), which has significantly affected the status of and current viability of the lynx population within this geographic unit. As discussed below under *Potential Threats/Stressors/Factors Influencing Viability*, there is significant risk of potential future wildfires to further affect the viability of lynx in this geographic unit. Recent wildfire severity, extent, and intensity in lynx habitat within this geographic unit may have been influenced by climate change (Westerling *et al.* 2006, pp. 942-943), and as

discussed below, climate change may similarly affect the future viability of lynx within this geographic unit.

4.2.5 Unit 5 - Greater Yellowstone Area

Unit Description: This geographic unit includes the parts of southwestern Montana and northwestern Wyoming the Service designated as critical habitat (Unit 5) for lynx in 2014 (79 FR 54825-54826). It encompasses approximately 23,691 km^2 (9,147 mi^2) in portions of Carbon, Gallatin, Park, Stillwater, and Sweetgrass Counties in Montana; and Fremont, Lincoln, Park, Sublette, and Teton Counties in Wyoming, with ownership that is 97.5 percent Federal (USFS, NPS, and BLM); 2.2 percent private; and 0.3 percent State. This unit includes parts of Grand Teton and Yellowstone national parks and the Bridger-Teton, Custer-Gallatin, and Shoshone national forests, and lands managed by the BLM's Kemmerer and Pinedale Districts. It includes parts of the Absaroka, Beartooth, Gallatin, Gros Ventre, Salt River, Teton, Wind River, and Wyoming mountain ranges. This unit is not directly connected to lynx habitats and populations in Canada or to other DPS populations, although lynx dispersing from the north likely arrived intermittently into the area historically and, more recently, some lynx released into Colorado traveled into and through this unit (see Devineau *et al.* 2010, p. 526). Relative to other DPS lynx populations, this unit is about 145 km (90 mi) southeast of the Northwestern Montana/Northeastern Idaho unit, and roughly 400 km (250 mi) northwest of the Western Colorado geographic unit.

Habitat Description: In northwestern Wyoming and the GYA, lynx are generally associated with Englemann spruce-subalpine fir and lodgepole pine of the Rocky Mountain Conifer Forest vegetation class, as described above (Section 4.1.3) for the northwestern Montana, although this habitat and, thus, lynx typically occur at higher elevations (2,000-3,000 m [6,550-9,850 ft]) in the GYA (McKelvey *et al.* 2000a, p. 245; ILBT 2013, p. 60). Potential lynx habitat in much of the GYA is naturally marginal (patchier and composed in many places of drier forest types), with fewer shrubs and a more open understory, and generally low to marginal hare densities, resulting in a spatially-limited distribution of lynx with large home ranges (Squires *et al.* 2003, pp. 5, 12-13; 68 FR 40090; 71 FR 66010, 66029; 74 FR 8624, 8643–8644; Hodges *et al.* 2009, entire; Berg and Gese 2010, p. 1750; 79 FR 54796; Lynx SSA Team 2016, p. 45). Among the three national forests that contribute lands to this geographic unit, potential lynx habitat was mapped on about 42 percent of the total national forest area (both inside and outside this SSA unit; USFWS 2007, pp. 32, 95, 122-123).

In Yellowstone National Park, 7,732 km^2 (2,985 mi^2; about 86 percent of the park) is considered "lynx forest types" (65 FR 16073), but only 2,784 km^2 (1,075 mi^2; 31 percent of the park, 36 percent of lynx forest types) is estimated to be potential lynx habitat (68 FR 40086). However, hares were completely absent from more than 36 percent of surveyed stands in Yellowstone National Park, and 96 percent had estimated hare densities below the 0.5 hare/ha threshold thought necessary to support resident lynx (Hodges *et al.* 2009, 870, 873-877). In contrast, estimated hare densities were >= 0.48 hares/ha in all surveyed stands on the Bridger-Teton National Forest in the southern portion of the GYA, with highest densities (1.7 hares/ha) in 30-70-year-old regenerating lodgepole pine stands with dense horizontal cover, and densities of

1.2 - 1.6 hares/ha in mature multi-storied spruce-fir and mixed spruce-fir (containing aspen or lodgepole pine) stands (Berg *et al.* 2012, p. 1483). In the central Wyoming Range in the southern part of this unit, hare tracks were more abundant in seral aspen stands with a significant spruce-subalpine fir component than in aspen stands with little or no spruce-fir, and hares appeared to be absent from pure aspen stands except where they bordered spruce/fir areas (Endeavor Wildlife Research 2009, p. 4). The only lynx den sites described for this unit (the natal den and a subsequent maternal den of one female in 1998) occurred in a mature subalpine fir-lodgepole pine forest in the Wyoming Range, where coarse woody debris and high sapling density provided dense horizontal cover (Squires and Laurion 2000, pp. 346-347).

Average annual snowfall in this unit ranges from about 127 cm (50 in) in Bozeman and 556 cm (219 in) in West Yellowstone, Montana, on the northern and northwestern peripheries of the unit, respectively, to 280-310 cm (110-122 in) in Alpine, Dubois, and Jackson, WY near the central and southern peripheries, with most snow falling from November to March in each place (https://snowfall.weatherdb.com/d/a/Montana; accessed 8/17/2016). In potential lynx habitats on the Bridger-Teton National Forest in the southern half of this unit, deep snow persisted from late October through May (Berg *et al.* 2012, p. 1481).

Habitat Status: Potential lynx habitats in this unit are currently designated as critical habitat in accordance with the ESA. Over 97 percent (23,109 km^2 [8,922 mi^2]) of this unit is in Federal ownership, including 18,877 km^2 (7,292 mi^2) in national forests under USFS management, 3,944 km^2 (1,523 mi^2) in national parks managed by NPS, and 271 km^2 (105 mi^2) managed by BLM. As described above in section 3.1.1, USFS lands in this unit are managed in accordance with the NRLMD, which formally amended all forest plans to adopt and implement lynx conservation measures (USFS 2007, pp. 8-30 and Attachment 1, pp. 1-9) that were developed based on the scientific findings and recommendations of the LCAS (Ruediger *et al.* 2000, pp. pp. 7-1 - 7-18). Similarly, the BLM in 2008 and 2010 revised its RMPs for the Pinedale and Kemmerer districts, respectively, to include conservation measures and BMPs for lynx based on the LCAS (BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). On lands with developmental land-use allocations, these amended forest plans and the revised BLM RMPs provide guidance on the kinds of activities that can and cannot be implemented in important lynx habitats and thresholds for the proportions of lynx habitat in LAUs that can be in an unsuitable state at any given time and how much can be converted from suitable to (temporarily) unsuitable over particular time frames. Implementation of these plans has likely benefitted lynx by providing a consistently-applied framework for conserving and restoring important hare and lynx habitats.

As elsewhere in the DPS (Squires *et al.* 2010, p. 1656; ILBT 2013, pp. 20, 27), winter foraging habitat is likely the most limiting habitat for lynx in this unit, and denning habitat is not thought to be limiting. Standards, guidelines and BMPs in the NRLMD and in revised BLM plans restrict vegetation management activities that could reduce winter snowshoe hare habitat and direct the creation or retention of coarse woody debris in areas where denning habitat may be lacking (USFS 2007, Attachment 1, pp. 2-5; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Snow conditions in this unit also appear to remain suitable to allow lynx to outcompete other terrestrial hare predators. Gonzalez *et al.* (2007, pp. 4-7) compared the highest-precision

lynx occurrence data in the contiguous U.S. from 1966-1998 with snow-cover data available for those locations and concluded that lynx require nearly continuous snow cover from December through March. The authors modeled the probability of suitable snow across North America, showing that most of this geographic unit has a 95 percent probability of providing snow cover conditions supportive of lynx presence (Gonzalez *et al.* 2007, p. 12).

This unit includes substantial areas in nondevelopmental land-use allocations, including (in addition to Yellowstone and Grand Teton national parks) the Absaroka-Beartooth, Bridger, Gros Ventre, Lee Metcalf, Northern Absaroka, Teton, and Washakie designated wilderness areas. Among the three national forests that contribute to this unit, 75 percent of potential lynx habitat is in designated wilderness or roadless areas (USFWS 2007, p. 34). Management activities in these areas are unlikely to adversely impact lynx and hare habitats.

Large parts of Yellowstone National Park burned in the extensive wildfires of 1988. Although the extent to which those fires may have impacted potential lynx habitats is uncertain, some of the burned areas may soon reach a stage of regeneration capable of supporting increased densities of hares, perhaps increasing the likelihood that lynx could reestablish and maintain home ranges in some parts of the park (Lynx SSA Team 2016, p. 45).

Because non-Federal lands make up less than 3 percent of lynx habitats in this unit, it is unlikely that activities on those lands have impacted lynx populations or meaningfully influenced the unit's current capacity to support resident lynx.

Overall, although naturally fragmented and patchily-distributed, potential lynx habitat in this geographic unit appears to be largely intact relative to historical conditions and disturbance regimes, with only a small proportion apparently impacted by past management (timber harvest and precommercial thinning) activities (65 FR 16072). Despite some likely localized impacts of past timber management and infrastructure (e.g., highway, railroad) development, past management activities do not appear to have diminished this unit's ability to support resident lynx or to have created barriers to lynx movement, or to have had other landscape- or population-level effects.

In summary, much of this geographic unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental land-use allocations, where management activities with the potential to adversely affect lynx habitat generally do not occur. Almost all lands with developmental land-use allocations in this unit are managed by the USFS to conserve and maintain lynx and hare habitats under management plans that were formally revised in 2007 in accordance with the NRLMD and based on the scientific findings and conservation recommendations of the LCAS. A small proportion of lands with developmental allocations occurs on BLM lands where management plans also were revised recently (2008 and 2010) to adopt conservation measures identified in the LCAS. Implementation of these USFS and BLM plans likely precludes landscape-level management-related adverse impacts to the vast majority of existing lynx and hare habitats in this unit. Nonetheless, past management activities that occurred prior to implementation of current regulations and other conservation efforts may exert continuing influence on current habitat quality in some places. Additionally, because lynx

habitats in this unit are naturally highly-fragmented and, in most places, support low landscape-level hare densities, relatively minor impacts, especially to hare and lynx winter foraging habitats, may strongly influence lynx persistence in some parts of this unit.

Lynx Status: There are no reliable estimates of the historical or current number of resident lynx in this unit. As described in section 2.3.2.2 above, the historical record and recent research show that the GYA has supported resident lynx, but it is unclear whether the area consistently supported a persistent resident population over time or whether it naturally supported resident lynx only intermittently. Most historical and recent verified lynx records are from the southern portion of this unit in the Gros Ventre, Salt River, Wind River, and Wyoming mountain ranges in the Bridger-Teton National Forest. Eighteen lynx were reported to have been trapped from a small area in the Wyoming Range in 1971-72 (Squires and Laurion 2000, p. 338), but it is unknown whether any of those lynx were residents (and if so, how many) or if some or all of them were dispersers associated with the "explosion" (irruption) of lynx documented in several places in the contiguous U.S. in the early 1970s (McKelvey *et al.* 2000a, pp. 235-242). However, two resident lynx, a male and a female, were trapped, radio-marked, and monitored in the Wyoming Range over several years beginning in 1996. The female produced four kittens in 1998 and two in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000 (Squires and Laurion 2000, p. 346; Squires *et al.* 2001, pp. 9, 26). The female's home range averaged 50 km^2 (19 mi^2) over the 3 years she was monitored, and the male's averaged 824 km^2 (318 mi^2) over five years (Squires *et al.* 2003, pp. 12-13). The male also made multiple long-distance exploratory movements (up to 728 km [452 mi], including multiple highway crossings) over 3 successive years (Squires *et al.* 2003, pp. 13-16; Squires and Oakleaf 2005, entire).

Other surveys also detected lynx in the southern portion of this unit from 1999-2009, with records most consistent in the Wyoming Range, Togwotee Pass, Union Pass, the Bondurant Corridor, and in the Gros Ventre Range (Squires *et al.* 2001, pp. 9-14; Squires *et al.* 2003, pp. 9-11, 29-31; Endeavor Wildlife Research 2008, 2009, entire; Berg 2016, *pers. comm.*; Squires *in* Lynx SSA Team 2016, pp. 20-21). Additionally, 10 radio-marked lynx released in Colorado subsequently moved into or through this portion of the GYA unit from 2004-2010, with locations concentrated in areas used previously by native Wyoming lynx (Devineau *et al.* 2010, p. 526; Hanvey 2016, *pers. comm.*). Several of the Colorado-released lynx occupied home ranges (including overlapping male and female home ranges) in areas of the Wyoming Range previously occupied by "native" resident lynx (Squires *in* Lynx SSA Team 2016, p. 21), but there is no evidence of reproduction among these lynx. On the Shoshone National Forest in the northeastern part of this unit, seven lynx snow tracks were confirmed by DNA analysis in winter 2005/06, and a single track was verified the following winter (Endeavor Wildlife Research 2008, p. 2; Berg 2016, *pers. comm.*). During the winters of 2004-05 through 2007-08, 26 snow tracks on the Bridger-Teton and Shoshone national forests were confirmed by DNA analyses to be from five individual lynx (3 males, 2 females). One of the males had previously been documented in Yellowstone National Park (see below). The other two males and both females were lynx that had been released in Colorado (Pilgrim 2016, *pers. comm.*).

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Verified records of lynx are less common elsewhere in this unit, including in Yellowstone and Grand Teton national parks and the Custer-Gallatin National Forest. There were no verified records of lynx in Yellowstone National Park from 1920-1999 (McKelvey *et al.* 2000a, p. 230); however, surveys in 2001-2004 documented at least 3 individual lynx, including two kittens, in the eastern part of the park (Murphy *et al.* 2006, entire). Several Colorado-released lynx also traveled through the park (Devineau *et al.* 2010, p. 526), and two possible (unconfirmed) lynx tracks were recorded in the park during winter 2008/2009 (Endeavor Wildlife Research 2009, pp. 4, 12). On the Custer-Gallatin National Forest in Montana in the northern part of the unit, a single female was detected over six consecutive winters (2003/2004 - 2008/2009) but not subsequently (Gehman *et al.* 2010, pp. 2-4), and it appears that she did not encounter a male or produce kittens during the six years she was detected (Gehman *et al.* 2010, p. 4).

Recent surveys and research-related trapping efforts have failed to detect lynx in this unit after 2010 (79 FR 54791; Squires *in* Lynx SSA Team 2016, pp. 20-21, 45; Hanvey 2016, *pers. comm.*). As discussed above and in section 2.3.2.2, it is uncertain whether this unit historically supported a small but persistent resident population that was recently extirpated, or if it historically and recently has supported resident lynx only intermittently. Given the protected conservation status of millions of acres in this unit, its apparent recent inability to support resident lynx may be a reflection of naturally marginal and patchy habitats and relatively low hare abundance in much of the unit, resulting in only an intermittent ability of this unit to support resident lynx (Lynx SSA Team 2016, p. 57). Conversely, the characteristics described above suggest that relatively small impacts could tip this unit from just barely able to support a persistent resident population to incapable of doing so. Further, the available evidence suggests that if this unit did support a persistent population, it was very likely a very small one, which would be more vulnerable to extirpation as a result of demographic, environmental, and genetic stochasticity, and to catastrophic events (McKelvey *et al.* 2000b, pp. 23-29), or to a combination of these factors.

Factors Affecting Current Conditions

Regulatory Mechanisms - As described above for Unit 3, Federal management activities (e.g., timber harvest and precommercial thinning, perhaps fire suppression) that occurred prior to listing and before implementation of current Federal regulatory mechanisms likely impacted some lynx and habitats by altering the distribution and quality of hare and lynx habitats. However, because these activities occurred in low proportions of lynx habitat on Federal lands and impacts appear to have been localized, they were deemed a low-level to threat to lynx at the time of listing (65 FR 16072-16076; 68 FR 40091-40095). Nonetheless, past Federal management activities may continue to influence the current quality and distribution of lynx habitats in some parts of this unit. Current regulatory mechanisms and conservation measures associated with recently amended or revised Federal management plans are intended to conserve and restore lynx and hare habitats across large landscapes. Although their effectiveness has not been quantitatively evaluated, they have almost certainly reduced significantly the potential for adverse management-related impacts to lynx habitats in this unit.

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Lynx trapping has been prohibited in Wyoming since 1973 (79 FR 54794) and in Montana since 1999 (MTFWP 2016, p. 7) and, as described in section 3.1.2, above, both states require measures to reduce the likelihood of trapping lynx incidentally when legally trapping other species. Since the DPS was listed in 2000, no lynx are documented to have been incidentally trapped in the Montana portion of this unit (MTFWP 2016, pp. 5-10) and we are aware of no incidental captures in northwestern Wyoming since listing.

Climate Change - As elsewhere, increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire all have been documented in this geographic unit (e.g., Mote *et al.* 2005, entire; Pederson *et al.* 2013; Riley *et al.* 2013; Dennison *et al.* 2014, entire; USEPA 2015, entire; Harvey *et al.* 2016, entire; Siren *in* Lynx SSA Team 2016, pp. 14-15; Westerling 2016, entire). A number of potential impacts to lynx have been described, and climate projections suggest these impacts are likely to result in future loss and increased fragmentation and isolation of lynx and hare habitats and declining lynx populations in the DPS (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15; see also section 3.2, above, and 5.1.3, below). Although climate change has probably already had some impact on lynx habitats in this geographic unit, and such impacts are likely to continue to occur, there currently is no evidence that climate change has had population-level effects or has reduced the ability of this unit to support persistent resident lynx populations. However, such impacts would be difficult to document and, as described under *Habitat Status*, above, because lynx habitats in this unit are naturally highly-fragmented and hare densities low in some places, relatively minor impacts, especially to hare and lynx foraging habitats, may strongly influence lynx persistence in some parts of this unit. Modeling vegetation and snow suitability for lynx across North America, Gonzalez *et al.* (2007, pp. 12, 15) indicated that boreal and temperate conifer forest biomes were broadly distributed across this geographic unit and that snow conditions suitable for lynx occurred with 95 percent probability from 1961-1990. (Future conditions based on this modeling are described in section 5.1.3, below). As described in section 3.2, above, climate change has also been implicated in recent increases in the frequency and intensity of outbreaks of boreal forest insect pests, with warmer winters resulting in increased insect survival and drought increasing conifer vulnerability to insects. This trend is expected to continue through the end of the century with continued climate warming (Bentz *et al.* 2010. pp. 607, 609).

Vegetation Management - The influence of vegetation management on the current condition of lynx and habitats in this unit is described above under Habitat Status and *Regulatory Mechanisms*, above.

Wildland Fire Management - As described above in section 3.4, wildfire suppression in this unit, as elsewhere in the West, has likely had little impact on lynx habitats (65 FR 16074; 68 FR 40093-94; USFS 2007, pp. 18, 20; USFS 2008, p. 11; ILBT 2013, p. 76). Also as described in that section, wildfire frequency, size, and intensity have increased in this geographic unit, likely in response to climate warming and related increases in drought conditions (e.g., Dennison *et al.* 2014, entire; Harvey *et al.* 2016, entire; Westerling 2016, entire), with most large, stand-replacing fires having occurred in the northern part of the unit, in Yellowstone National Park (see

Harvey *et al.* 2016, Fig. 1). Despite this increase, we are aware of no evidence that increased fire activity in the unit has thus far impacted resident lynx populations or reduced this unit's ability to continue to support resident lynx.

Habitat Loss and Fragmentation - As described above, the dominant land use in this unit, and that most likely to result in habitat loss and fragmentation, is timber harvest and associated vegetation management (e.g., precommercial thinning) and road construction on lands with developmental allocations. Much of this unit occurs in national parks, designated wilderness and roadless areas, or other nondevelopmental allocations. Even in areas with developmental allocations, the moist subalpine forests important to lynx have had less timber harvest, road construction, and have been modified much less than other drier forests (65 FR 16073), and these activities appear not to have had population-level impacts on lynx or to have measurably reduced the ability of this geographic unit to support resident lynx. Few highways intersect lynx habitats in the Northern Rockies (ILBT 2013, p. 63) and there are few records of lynx killed by vehicle collisions in Montana (5) and Wyoming (1; a Colorado-released lynx) (Broderdorp, unpubl. data; MTFWP unpubl. data). Other potential sources of habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors - Connectivity/Immigration - As elsewhere in the range of the DPS, resident lynx populations in this geographic unit are thought to be influenced by connectivity with, and immigration of lynx from, populations in Canada (see section 2.2, above). However, whether and, if so, to what the extent the persistence of populations in this geographic unit may depend on regular or intermittent immigration of lynx from Canada remains uncertain, and historic, recent, and current immigration rates of are unknown. Although this unit is not directly connected to lynx habitats and populations in Canada or elsewhere in the contiguous U.S., no barriers to lynx dispersal from the north have been identified, and 10 lynx released in Colorado are known to have dispersed northward into and through this unit (Devineau *et al.* 2010, p. 526; Hanvey 2016, *pers. comm.*), demonstrating that dispersal between the southern and northern Rockies is possible. As described above in Lynx Status, the large number of lynx reportedly trapped from a small area of the Wyoming Range in the early 1970s (Squires and Laurion 2000, p. 338) may suggest dispersers associated with the irruption of many lynx from Canada into the northern contiguous U.S. documented at that time (McKelvey *et al.* 2000a, pp. 235-242). No subsequent pulses of lynx dispersing from the north have been documented, and lynx trapping records suggest that the magnitude of lynx populations cycles in Alberta and British Columbia, the most likely source of lynx dispersing southward into this unit, dampened dramatically after the early 1980s (McKelvey *et al.* 2000a, p. 226; Bowman *in* Lynx SSA Team 2016, p. 13; also see Appendix 5, 2015 10 13 - 5, pp. 4-5 [https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/SSA2016/Appendices/Appendix%205%20Presentation%20PDFs/2015%2010%2013%20-%205%20-%20Bowman%20Lynx%20Southern%20Canada.pdf]).

As described in section 3.2, above, a number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the

contiguous U.S. If lynx populations in this geographic unit are reliant on immigration from Canada which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and a reduced probability of persistence among resident populations would be expected. Although the extent to which this factor has influenced the current condition of lynx populations in this unit is unknown, it is possible that it has contributed to the recent apparent loss of resident lynx from this unit.

4.2.6 Unit 6 - Western Colorado Geographic Area

Unit Description - This geographic unit includes the Southern Rocky Mountains of western Colorado. Small areas of similar potential lynx habitat extend into south-central Wyoming and north-central New Mexico, and some lynx released in Colorado traveled into or through those areas. However, there is no evidence that either area supports resident lynx, and we question their ability to do so. Potential lynx habitat in Colorado totals approximately 25,294 km^2 (9,766 mi^2), and is distributed west of US Interstate 25. We excluded the northwest part of the State, bounded on the south by US Interstate 70 and the east by Colorado State Highway 13, because this area lacks sufficient habitat to support lynx. Lynx habitat in this unit occurs within the following land ownerships: USFS (85 percent), BLM (3 percent), NPS (2 percent), private (9 percent), and State (< 1 percent).

The Southern Rockies are separated from the rest of the Rocky Mountain chain, and thus from lynx habitat in northwestern Wyoming, by sagebrush and desert shrub communities in the Wyoming Basin and the Red Desert of southern and central Wyoming, and the arid Green and Colorado River plateaus of western Colorado and eastern Utah. Connectivity of lynx habitat has been identified as an important consideration for the Southern Rockies, because of the extreme topographic relief juxtaposed with human developments such as highways and residential communities.

Habitat Description - Lynx habitat in the Southern Rockies is found within the subalpine and upper montane forest zones, generally above 2,900 m (9,514 ft) elevation (Shenk 2009, p. 10). In the upper elevations of the subalpine zone, forests are typically dominated by subalpine fir and Engelmann spruce. As the subalpine zone transitions to the upper montane, spruce-fir forests begin to give way to lodgepole pine and aspen. On cooler, mesic mid-elevation sites, Engelmann spruce may retain dominance, intermixed with aspen, lodgepole pine, and Douglas-fir. Lodgepole pine reaches its southern limits in the central part of the geographic unit, while southwestern white fir occurs only in the San Juan Mountains. The lower montane zone is dominated by ponderosa pine and Douglas-fir, with pines typically dominating on lower, drier, more exposed sites, and Douglas-fir occurring on the more sheltered sites. Lower montane forests do not support snowshoe hares and seldom would be used by lynx.

Mature Engelmann spruce/subalpine fir forests with total canopy cover of 42–65 percent, of which 15–20 percent was contributed by conifer understory tree canopies, were the most commonly used areas, followed by mixed forests of Engelmann spruce/subalpine fir/aspen (Shenk 2008, p. 15). Riparian and riparian-mix was the third most-used cover type, with a

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pattern of increasing use beginning in July, peaking in November, and dropping off in December. Large or medium willow/alder carrs and willow riparian communities provided important habitat for snowshoe hare, grouse, ptarmigan (winter), and other prey species that could be utilized by lynx.

Ivan *et al.* (2012, p. 5) confirmed some relationships that were already known (e.g., lynx are strongly associated with high-elevation spruce/fir and mixed spruce/fir forests but avoid lower-elevation montane forests and montane shrublands). We recognize that all spruce-fir forest does not support lynx equally based on the low detection rate (28 percent) reported during the ongoing lynx study in the San Juan Mountains within predominantly spruce-fir forest (Ivan *in* Lynx SSA Team 2106, p. 14), thus not all areas of spruce-fir forest are used by lynx.

Dolbeer and Clark (1975, p. 539) estimated a density of 0.73 hares/ha (0.3 hares/ac) within their study site in Colorado, with the highest densities of snowshoe hare in mature and late-successional spruce-fir forests. However, this study was conducted in a very limited area and did not sample younger sapling-stage stands (15-40 years post-disturbance) to compare hare densities with those reported for mature and late-successional spruce-fir forests (USFWS 2008b, p. 32).

Habitat that supports snowshoe hares is patchily distributed in the Southern Rocky Mountains, including the Western Colorado Geographic Unit, which limits their abundance. Zahratka and Shenk (2008, entire) found densities of snowshoe hares to be greatest in mature Engelmann spruce-subalpine fir stands when compared to mature lodgepole pine stands in Taylor Park, Colorado. Their density estimates were 0.08±0.03 to 1.32±0.15 hares/ha (0.03–0.5 hares/ac) in Engelmann spruce-subalpine fir habitats, and 0.06±0.01 to 0.34±0.06 hares/ha (0.02–0.14 hares/ac) in lodgepole pine habitats (Zahratka and Shenk 2008, pp. 910-911).

Ivan (2011*a* *in* ILBT 2013) compared snowshoe hare density, survival, and recruitment in mature uneven-aged spruce/fir stands, small-diameter lodgepole pine (2.54–12.7 cm [1–5 in]) stands (20–25 years old), and medium-diameter (12.7–22.9 cm [5–9 in]) previously-thinned lodgepole pine stands (40–60 years old) in Colorado. During summer, Ivan (2011*a* in *ILBT 2013*) recorded densities of 0.2+0.01 to 0.66+0.07 hares/ha (0.08–0.27 hares/ac) in small lodgepole pine forest, 0.01+0.04 to 0.03+0.03 hares/ha (0.004–0.01 hares/ac) in medium lodgepole forest, and 0.01±0.002 to 0.26±0.08 hares/ha (0.004–0.1 hares/ac) in spruce/fir forest; densities were more similar across the 3 forest types during the winter months. He concluded that "hares reached their highest densities and recruited juveniles most consistently in stands of small lodgepole, followed closely by spruce/fir, but survival was highest in spruce/fir stands."

Habitat Status - At the time of the 2000 listing, we identified 26,305 km^2 (10,156 mi^2) of potential lynx habitat in the Southern Rockies (i.e., western Colorado and southern Wyoming; [65 FR 16052]). In 2003, we estimated 31,027 km^2 (12,419 mi^2) of potential habitat within the Southern Rockies (68 FR 40076). As stated above, our focus here is limited to the State of Colorado. In 2008, the USFS reported that most of their LAUs in the Southern Rockies fell within a range of

3-8 percent in a currently unsuitable condition, with only one LAU exceeding 30 percent unsuitable (USFS 2008, p. 19). Currently, the USFS reports 51 out of 202 (25%) LAUs currently exceed the 30 percent unsuitable condition (P. McDonald 2016, *pers. comm.*). These changes are mostly in response to the ongoing bark beetle infestations, as well as wildfire events that have occurred since 2008.

Ivan (2011e, entire), developed a predictive map of lynx habitat use by using lynx location data collected during CPWs reintroduction monitoring, then estimated the amount of habitat associated with a high probability of detecting lynx. Our review of the vegetative characteristics of CPW's predictive map detected large areas of spruce-fir habitats that were excluded by their presentation of the habitat associated the top 20 percent of predicted use (Ivan 2011e, p. 26). Therefore, we selected the top 30 percent of the Ivan (2012, entire) predictions and the associated habitat to represent the amount of potential lynx habitat in Colorado totaling 25,294 km^2 (9,766 mi^2). This habitat estimate falls between the Ivan (2011e, p. 26) estimate and the USFS's habitat estimate of 30,664 km^2 [11,839 mi^2] (USFS 2008, p. 18), while retaining a greater than 60 percent probability of detecting lynx as described by Ivan (2011e, pp. 32-33).

Regulatory mechanisms in Colorado are largely provided through Forest Service planning documents. All USFS land management plans within the unit were amended in 2008 to provide for the conservation of lynx. Three BLM plans in Colorado have been amended or revised to conserve lynx following the 2013 LCAS on lands totaling approximately 126 km^2 (49 mi^2) of potential lynx habitat. One additional plan provides conservation measures for timber management actions only, but the FO contains only about 1 km^2 (0.39 mi^2) of potential lynx habitat. The remaining FOs currently have not amended or revised their plans specifically to provide conservation for lynx (these plans combined guide management of approximately 645 km^2 (298 mi^2) of potential lynx habitat. Since the 2000 listing, however, all BLM Field Offices in Colorado have been conserving lynx discretionarily through application of conservation measures provided in the Lynx Conservation Assessment and Strategy (Ruediger *et al.* 2000, entire; ILBT 2013, entire). Rocky Mountain National Park has a fire management plan that includes conservation measures for lynx. We are not aware of any specific conservation planning guiding activities on non-Federal lands (M. Wrigley 2016, *pers. comm.*; M.K. Watry 2016, *pers. comm.*).

Lynx Status - As of 2016, the current distribution of lynx is somewhat uncertain within Colorado. However, we believe it is reasonable that lynx continue to occupy all National Forests within the State of Colorado (Odell 2016, undocumented *pers. comm.*), and Rocky Mountain National Park (Shenk 2008, p. 3). The CPW is developing a minimally-invasive, long-term, statewide monitoring program to track the distribution, stability, and persistence of lynx in Colorado (Ivan 2011e, entire).

As of 2015, evidence of recent lynx reproduction is provided through kittens captured on game cameras accompanying adult females at three locations during 2014-2015 monitoring effort (Ivan *in* Lynx SSA Team 2016, p. 17). In addition 38 percent of lynx captured during recent (2010-2015) USFS Rocky Mountain Research Station research projects in Colorado have been

young and/or unmarked cats (Ivan *in* Lynx SSA Team 2016, p. 17), suggesting continued reproduction within Colorado. However, reproductive rates are currently unknown.

As of 2007, the average probability of survival for reintroduced lynx was 0.9315±0.0325 within the study area in the San Juan Mountains and 0.8219±0.0744 outside the study area boundary (Devineau *et al.* 2010, p. 5). Although 30 percent of known mortalities were due to human causes (being shot or hit by a vehicle), the estimate of survival within the study area was higher than those reported for natural, lightly trapped populations of Canada lynx in the Yukon (0.75–0.90; Slough and Mowat 1996, entire; O'Donoghue *et al.* 1997, p. 155) or in the Northwest Territories (~0.90; Poole 1994, p. 612). Successful reproduction, including by females born in Colorado, has been documented (Shenk 2008, p. 2), and kitten survival was 0.2260 (Ivan 2016b, *pers. comm.* March 9, 2016).

Factors Affecting Current Conditions

Colorado is currently experiencing major bark beetle epidemics in lodgepole pine and spruce-fir forests. Although bark beetles are native insects, and forests in the western U.S. have experienced regular insect infestations throughout their history, the current bark beetle epidemic is notable for its intensity and extensive geographic range. The causes of this epidemic include: relatively even-aged, dense, and homogenous forest conditions, which are highly susceptible to beetle attack, and which were created by large-scale logging in the late 1800s and subsequent fire suppression efforts; warmer winters as a result of climate change (cold winters typically reduce beetle populations); and a multi-year drought that occurred in the mid-1990s through early 2000s, stressing the trees and making them more susceptible to beetle attack (USFS 2011, p. 4).

In lodgepole pine forests, a mountain pine beetle epidemic typically kills the entire overstory and results in a stand-replacing disturbance event. In Colorado, more than 1,375,931 ha (3,400,000 ac) has been affected by mountain pine beetle, and 639,000 ha (1,579,000 acres) affected by spruce beetle since 1996 (USFS 2015, p. 3), a portion of which overlaps with lynx habitat.

Even-aged mature and "dry" lodgepole pine stands characteristically have depauperate understory vegetation and are not capable of supporting dense populations of snowshoe hares. On moist sites, regeneration of beetle-killed lodgepole pine stands is expected to be relatively rapid 20-30 years, and the new stands will be dominated by resprouting aspen or by a new cohort of lodgepole pine. If these newly-established stands grow tall and dense enough to provide horizontal cover above the snow layer, they may produce excellent habitat for snowshoe hares and lynx for several decades, until the crowns again lift above the reach of snowshoe hares.

A spruce beetle epidemic kills the larger-diameter trees and can also result in a stand-replacing disturbance event. Because of the importance of spruce-fir forests for production and survival of snowshoe hares (Ivan 2011a *in* ILBT 2013), widespread mortality of mature spruce/fir forests could impact lynx habitat for a long duration. By 2015, the spruce beetle outbreak influenced approximately 95 percent of the mature spruce component of the subalpine cover types on the

Rio Grande National Forest (Squires *et al.* unpublished report 2016, p. 1). Despite the large scale, and almost complete mortality of the mature spruce component within their study area, lynx continue to use and reproduce in the beetle-infested forests (Squires *et al.* unpublished report 2016, p. 2). Since the majority (88 percent) of lynx habitat in Colorado is under Federal land management, actions occurring on other ownerships are unlikely to result in significant losses of lynx habitat within Colorado. However, habitat connectivity may be negatively affected by intense recreational use or development within strategic areas that are important for habitat connectivity.

ILBT (2013 p. 57; 61-62) states:

> *Plague, a flea-borne disease caused by the bacterium Yersinia pestis, which is not native to North America, was reported for the first time in lynx in Colorado (Wild et al. 2006). Pneumonic plague appeared to be the direct or indirect cause of death of 6 reintroduced lynx between 2000 and 2003. When translocated from Canada and Alaska, none of the lynx had antibody titers to Y. pestis; it appears likely that lynx were exposed to plague by infected prey after their release in Colorado.*
>
> *Vehicular collisions are a potentially important cause of mortality for lynx in portions of the southern Rockies. Thirteen of 102 mortalities documented for lynx translocated into Colorado were from vehicle collisions (Devineau et al. 2010). Brocke et al. (1990) suggested that translocated animals might be more vulnerable to highway mortality than resident lynx and this could have been a factor in Colorado at the time of listing. Currently, the majority of lynx mortalities caused by vehicle collision (13 of 16) occurred during the reintroduction period (1999-2006). Since early 2007, one year after the final reintroductions occurred, only 3 hit by vehicle mortalities have been reported, and only two of those occurred in Colorado (Broderdorp unpublished data 2016). A number of highways with high speed and high traffic volume pass through lynx habitat, such as I-70, I-80, US 50, US 550 and US 160. These highways are not a barrier to lynx movement, as repeated successful crossings by radio-telemetered lynx have been documented on I-70 and Highways 9, 40, 50, 91, and 114 (Ivan 2011b, c, 2012; J. Squires, personal communication 2012). At this time, it appears that hit by vehicle mortality may be a less significant mortality factor for lynx in Colorado.*
>
> *As compared with other portions of the range of lynx, in Colorado more winter recreation and associated development overlaps with lynx habitat. Preliminary information from a study in Colorado indicates that some winter recreation uses may be compatible, but lynx may avoid some developed ski areas (J. Squires, personal communication 2012). It is possible that ski areas and 4-season resorts may reduce the amount and availability of lynx habitat within localized areas, in part by influencing the distribution or abundance of prey resources within the developed area. However, there is also considerable anecdotal evidence of lynx using ski areas.*

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Leg-hold trapping is currently prohibited under the state constitution of Colorado as a means of predator control or for commercial and recreational trapping. If a landowner can prove that all other non-lethal methods have been ineffective, a 30-day exemption may be granted for depredation cases. Incidental trapping mortality of lynx may be a minor risk during trapping seasons in southern Wyoming and surrounding states.

Predator control activities on federal lands, including coyote shooting or trapping, are common throughout most of this geographic area, mostly related to the grazing of domestic sheep. The majority of sheep grazing occurs on arid rangelands, but some grazing does occur during summer at the higher elevations, especially in south-central Colorado. Incidental capture of lynx is possible, but unlikely.

Chapter 5: Future Conditions

In this chapter, we present our assessment, based on the best available scientific information, including our analysis of input from lynx experts, of the future condition of the lynx DPS in terms of redundancy, representation, and resiliency. We then provide brief summaries of the possible future conditions in each geographic unit, followed by a more detailed evaluation of the factors likely to influence lynx populations and habitats in each unit. We elicited expert input on the probabilities that resident lynx populations will persist because we lack reliable estimates of the sizes and trends of lynx populations in each geographic unit and in the DPS, and because existing demographic data are inadequate to construct empirical models to project population sizes, trends, and viability into the future. We present and summarize the professional judgments and opinions of a panel of 10 lynx experts regarding the factors likely to influence the persistence of resident lynx populations in each of the six geographic units. We also present and summarize the experts' projections, based on consideration of those influencing factors, of the probability that each of the geographic units will continue to support resident breeding populations of lynx into the future (at years 2025, 2050, and 2100), and the sources of uncertainty that influenced their confidence in their predictions.

We then present our evaluation of the scientific literature regarding how certain anthropogenic factors may influence future conditions for resident lynx in each geographic unit. The factors we consider for each geographic unit include regulatory mechanisms (the factor for which the DPS was originally listed under the ESA) and the anthropogenic influences identified by the Interagency Lynx Biology Team (ILBT) as having the potential for population-level impacts to lynx in the DPS (climate change, vegetation management, wildland fire management, and habitat loss/fragmentation; ILBT 2013, pp. 68-78; see also Chapter 3, above). Other factors were also evaluated for some geographic units if the Core Team member most familiar with that unit felt those factors could pose meaningful, even if less likely, risks to the unit's continued ability to support resident lynx. After considering all of the above, we present our conclusions regarding the future conditions for resident lynx populations in each geographic unit and we discuss the extent to which our conclusions agree with or differ from the projections provided by the lynx expert panel we consulted and, if they differ, why.

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Implicit in our evaluation of the future for lynx in the contiguous U.S. is our recognition and consideration of a future in which the DPS is not listed under the ESA. However, given the DPS's listing history and the ESA's requirements for delisting, we do not evaluate the unlikely hypothetical future in which the DPS is not listed and all protections and conservation efforts disappear. Rather, we assume that although some protections could be relaxed (e.g., less stringent analyses of project-related impacts, potential for some states to reinstitute limited trapping/hunting harvest), that conditions for delisting would include requirements and incentives to continue to conserve lynx and its habitats and to assure persistence of resident lynx populations in those places that can support them on Federal, State and Tribal lands (perhaps some private lands as well). Our evaluation, therefore, considers the possibility of the future relaxing of some lynx conservation measures and efforts, but not the complete absence of all protections for lynx. Some of the experts we consulted indicated that their projections assumed the status quo (i.e., continued protections under the ESA and current Federal and State land management policies). Others indicated their persistence probabilities were not influenced by regulatory considerations but that doing so would not have altered their projections; they felt that factors influencing lynx persistence on the landscape are independent of ESA listing status (Lynx SSA Team 2016, p. 52).

Additionally, we do not to define and evaluate specific and explicit climate change/ greenhouse gas emissions scenarios or attempt to quantify differences in DPS viability or the persistence of resident lynx populations in individual geographic units based on differences in the rate and extent of potential impacts associated with projected continued climate warming. This is because of the limited resolution and inherent uncertainty of available climate models and the inadequacy of existing demographic data for projecting lynx populations in the DPS over time, including their potential responses to a range of climate-mediated potential future habitat conditions. Therefore, this SSA does not constitute or include a formal climate change vulnerability assessment (Glick *et al.*, editors, 2011, entire) for the lynx DPS. Instead, underlying our evaluation in this SSA is the recognition that the lynx, as a broadly-distributed boreal forest- and snow-reliant predator that relies heavily on a single, similarly-specialized prey species, and whose habitats are naturally influenced by climate-mediated disturbance factors (e.g., wildfire, forest insects, wind/ice storms, etc.), is likely highly sensitive and broadly exposed to the impacts of climate change and has limited adaptive capacity to respond to it. Therefore, we (along with the experts we consulted and the ILBT) consider lynx populations in the DPS vulnerable to the projected impacts of continued climate warming. While we recognize that the pace and extent of impacts would be expected to differ under specific emissions or modeling scenarios, the limitations described above preclude us from quantifying those differences and their potential influence on the probabilities that resident lynx will persist in the DPS or in individual geographic units.

5.1 Summary of Future Conditions DPS-wide

Given the irresolvable uncertainty about the historical distribution of resident lynx in the contiguous U.S. and the current lack of reliable estimates of the sizes, trends, and many demographic parameters for most DPS populations, it is difficult to confidently predict the future

condition of the DPS or the likelihood that any given geographic unit will support resident lynx in the future. We lack data to build rigorous empirical population models for lynx in the DPS, and uncertainty regarding the timing and magnitude of potential impacts to lynx from continued climate warming also limits our ability to predict the future condition of the DPS. Therefore, our assessment of the future condition of the DPS is based on our evaluation of the available scientific information regarding the factors identified by the ILBT as the most likely to have population-level impact to lynx in the DPS (ILBT 2013, pp. 68-78), including the best professional judgments and opinions of lynx experts.

Overall, our evaluation of the scientific literature and expert input suggests that resident lynx populations in each of the geographic units and, therefore, in the DPS as a whole, are likely to be smaller and their distributions reduced in the future. These anticipated declines are likely to be most influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations; Lynx SSA Team 2016, p. 58). This outcome seems likely regardless of which climate emissions scenario is used to model future conditions, although the timing, extent, and magnitude of impacts is uncertain and will likely vary by scenario.

In addition to climate change, forest management also has the potential to influence (negatively or positively) hare and lynx habitats in the DPS range. Forest management on private lands that lack lynx conservation commitments may contribute to future declines in the amount and quality of lynx habitats, particularly in Maine and perhaps also in Minnesota (private lands contribute minimally to lynx habitats in the other geographic units – see Table 2, above). Uncertain future forest ownership and markets for forest products, shifts in silvicultural practices, and development pressures on private lands all may affect the resiliency of future lynx populations and thus the units. The lack of evaluation of the effectiveness of forest management plans for lynx on Federal lands is of concern for western units.

In each geographic unit, the experts we consulted expect the probability that resident lynx populations will persist will decline in the future, although uncertainty about persistence probability increases with time from the present (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below). Although all five geographic units that currently support resident populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) had an expert-estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century. Expert input suggests that all other geographic units individually have a 50-percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century (Lynx SSA Team 2016, pp. 36-49; also see 5.2, below), and a cumulative likelihood that resident lynx will be lost from two or three of the five units that currently support them by the end of the century (Figure 7).

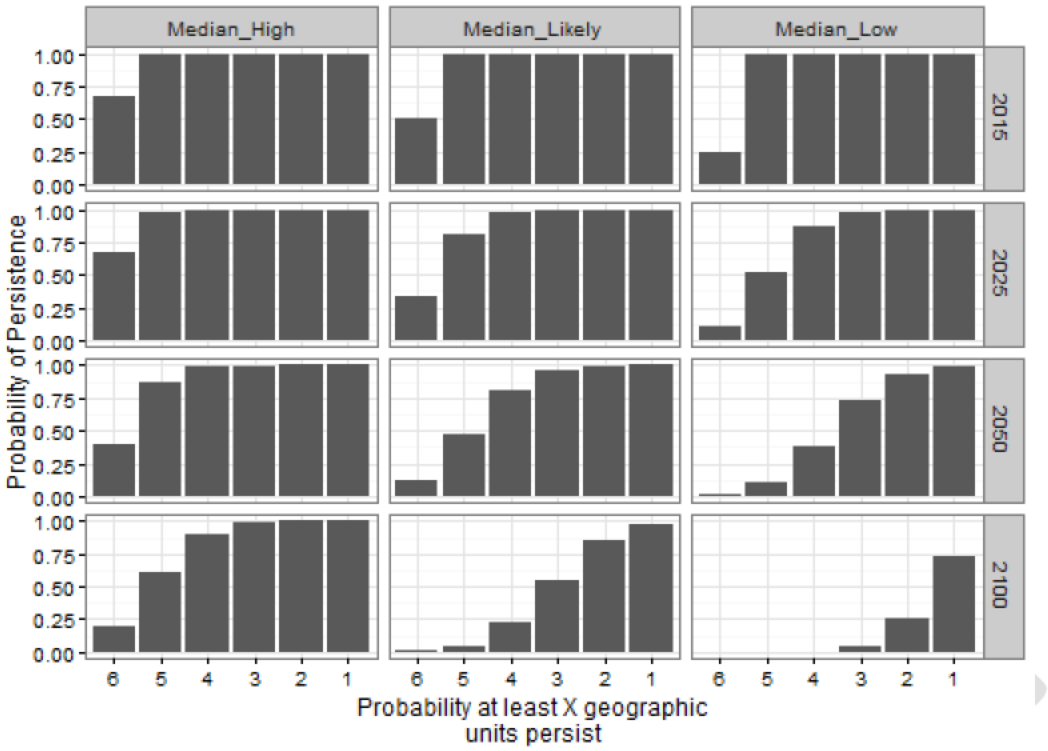


Figure 7. Summary of lynx experts' predictions regarding the probability of persistence of at least a given number of geographic units given the probability of persistence for each individual geographic unit. The y axis of each grid in Figure 7 is the probability that at least the number of geographic units indicated by the x axis of the grid persist. The probability in a bar reaches 1 when there is no probability of fewer geographic units persisting. Moving from top to bottom the grids show the probabilities by time period (2015, 2025, 2050, and 2100). Moving from left to right the grids show the range of expert responses by summary selection type and probability response. Therefore, looking down a column of grids provides a view of the trend in persistence through time and looking across a row of grids provides a view of the range of uncertainty in persistence for a given time period.

Our evaluation generally concurs with the expert input we received. We believe that lynx populations and habitats in the DPS will decline over time largely as a result of continued climate warming and associated impacts, which are likely to exacerbate the potential adverse effects of other factors (e.g., forest management, competition from other hare predators). We conclude that, at mid-century, resident lynx populations are likely to persist in most geographic units that currently support them. However, we conclude it is very unlikely that resident lynx populations will persist through the end of this century in all five of the geographic units that currently support them. That is, we believe it is more likely than not that resident lynx will be functionally extirpated by the end of the century from one or more of the five geographic units that currently support them.

We acknowledge that under a "worse case" climate modeling scenario the boreal and subalpine forests and snow conditions lynx need could completely disappear from some units and be

substantially reduced in the remainder by the end of the century (we are aware of no climate modeling that suggests the complete disappearance of potential lynx habitat from the entire contiguous U.S. by the end of the century). Complete loss of lynx habitat is perhaps more likely in the Northern Maine and Northeastern Minnesota units where there is little potential for elevational refugia compared to the more topographically diverse units (3 through 6) in the western U.S. Under such a scenario, resident lynx would be unable to persist in some units and severely restricted in number and distribution in others, with any remaining resident populations more vulnerable to demographic, environmental, and genetic stochasticity and to catastrophic events than is currently the case.

Conversely, under a "best case" climate scenario (perhaps combined with a "best case" future forest management scenario), it is possible that resident lynx could continue to persist through the end of the century in all five geographic units that currently support them. Even under this scenario, however, we would expect smaller population sizes and reduced distributions in each unit resulting from the impacts of even moderate continued climate warming (we are aware of no models that predict climate cooling or climate-mediated improvement in lynx habitat conditions in the contiguous U.S. over the next century). We cannot quantify the likelihoods of either of these extreme scenarios nor improve the precision of, or our confidence in, the experts' predictions regarding persistence. Nonetheless, we believe the most likely future condition of the DPS is that resident lynx populations will continue to persist at the end of the century in two or three of the five units that currently support them (i.e., they will be functionally extirpated from two or three of the units) and that even where populations persist, they will be reduced in number and distribution and, therefore, resiliency.

The loss of viable resident lynx populations from one or more geographic units would represent reduced future redundancy, representation, and resiliency within the lynx DPS. With regard to redundancy, however, our evaluation of the scientific literature and expert input indicates that no individual geographic unit that currently supports resident lynx is vulnerable to extirpation from a single catastrophic event. Given that, we conclude that the DPS as a whole is not vulnerable to extirpation from a catastrophic event (i.e., we find that there is a zero probability that a single catastrophic event could result in extirpation of resident lynx from any of the five geographic units that currently support them and, therefore, a zero probability of catastrophic extirpation of the entire DPS). As described above (section 1.3), we do not consider continued anthropogenic climate warming a catastrophic event; rather, we consider it a separate, ongoing, and pervasive stressor, not a single temporally- and spatially-discrete event. We recognize that a sequence of discrete but spatially-clustered catastrophic events in lynx habitats over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (especially the possibility of additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation of the DPS from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is

uncertain, there seems to be little risk of significant genetic drift. This is because of the currently observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, and the current and likely future connectivity and absence of significant barriers to dispersal between Canada and most DPS geographic units. Based on these factors and expert input, we find that is there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51) and no indication that future gene flow is likely to be substantially reduced (79 FR 54793). This information suggests the current and likely future relative genetic health of the DPS.

How the potential loss of resident lynx from one or more geographic units may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Because resident lynx populations in all geographic units that currently support them are expected to be smaller and more fragmented and isolated in the future, each geographic unit and the DPS as a whole will be less resilient in the future. Our analyses and expert input suggest that resiliency will likely be adequate to foster persistence of resident lynx in most units through mid-century but that it will be substantially diminished after that time, with resulting extirpation of resident populations from two to three (of five) units by the end of the century. Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible (i.e., less resilient) to stochastic events.

5.1.1 Summaries of Future Conditions in Each Geographic I Unit

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Unit 1 – Northern Maine: Although the Northern Maine geographic unit currently has extensive lynx habitat, it may be one of the units in the DPS at greater risk. Forestry practices, climate change, habitat loss and fragmentation, and development will be the greatest future drivers of hare and lynx habitat in this unit. Lynx habitat and numbers are expected to decline by 50 to 60 percent by 2032 in response to aging of the budworm-era clearcuts and the effects of 27 years of extensive partial harvesting. In the next few decades, high quality hare habitat will drop from about 10 percent to 5 percent of the landscape. High quality habitat patches will become more fragmented, smaller, and more isolated, thus making the landscape less suitable for lynx. For the next few decades the best habitat will occur in the southern portion of the range where effects of climate change and competition with bobcats are likely to be greatest. Absent long-term lynx management agreements, the future of lynx habitat is uncertain. Wood products markets will continue to change, and could be affected by interest in carbon sequestration in response to climate change. Rapid changes in private forest land ownership are likely to continue resulting in subdivision of large ownerships. Non-forestry land uses (wind energy development, transmission line corridors, residential and resort land development, and unmanaged, conservation lands) will compete with forest management as the primary land use. Conservation easements will help reduce development pressures and keep some lands as working forest, but forest practices (e.g., partial harvesting, northern hardwood management) may not be conducive to creating new lynx habitat. Climate change is expected to affect the Maine unit more than others in the DPS because snow depth and duration already seem to be at thresholds for lynx and there are few potential elevational refugia. In the near term and to mid-century, snow quantity and quality will continue to deteriorate, likely causing the range of lynx to begin contracting northward.

Our review of the published literature and input from lynx experts lead some members of the SSA Core Team to conclude that lynx could become extirpated from the unit by mid- to late-century. Climate change, increasing demand for hardwood forest products, a pending spruce-budworm outbreak, and frequent disturbance of the forest all will contribute toward the trend in the loss of spruce-fir forest and expansion of northern hardwoods, although the timeframe for conversion is uncertain. The lynx experts we consulted indicate the probability of persistence will decline to about 50% by the end of the century, although there was wide variation in opinions. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, lack of elevational refugia), some members of the Core Team were more pessimistic about the future of lynx in Maine than the lynx expert panel. In particular, we observed that there is great uncertainty about the future of forest management and future development on private forest lands. We also note that the threat for which the lynx DPS was listed, the lack of specific conservation direction in Federal forest planning and management regulations and direction, has not been addressed on private lands. There are no long-term management plans in place, State forest regulations have greatly influenced harvesting practices that have (and will continue to) reduce landscape hare densities, markets for forest products are depressed, and projections (under current harvest scenarios) are that habitat will diminish and shift southward in the near term because of post-harvest succession and recede northward over the longer-term because of continued climate warming.

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Unit 2 - Northeastern Minnesota: The direct and indirect effects of climate change are expected to affect lynx into the future in Minnesota. Specifically, the quantity, quality, and duration of snow are projected to decline; competition and hybridization with bobcats are likely to increase as snow conditions favorable to lynx are diminished; boreal conifer forests are projected to contract northward, resulting in increased habitat loss and fragmentation and increased isolation of Minnesota lynx is anticipated with diminishing forest conditions in Ontario. The probability of persistence of the lynx population in Minnesota is projected to decrease over time with increasing uncertainty through the end of the century, driven in the near term by the quality, quantity and persistence of snow, competition, disease, and forest insects, and over the long term from some of the same factors with the addition of climate change, loss of spruce-fir forests, and (projected increases in?) wildfires. If the SNF in Minnesota continues to follow vegetation management and other recommendations under the LCAS in their Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. It is not clear if the Forest will maintain that commitment into the long term. If the DPS is de-listed, the species would be placed on the Forest's Regional Forester Sensitive Species list for at least 5 years, which gives it a higher priority than other species for monitoring and management during that time. It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue on State and private lands. However, it is unclear on what proportion of State and private lands these voluntary actions will be implemented into the future. Further, these guidelines are generalized for listed species and give no specific direction for lynx. Taking all factors into consideration (i.e., loss of boreal forest, increased competition, potential disease and insect outbreaks, loss of snow), lynx experts projected the mean probability persistence of lynx in Minnesota to the year 2025 was greater than 90 percent, to 2050 was 80 percent, and would decline to approximately 35 percent by 2100. After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, loss of boreal forest, lack of elevational refugia, increased competition, potential disease, and insect outbreaks), some members of the SSA Core Team were slightly more pessimistic about the future of lynx in Minnesota than the lynx expert panel. The Core Team concluded that the climate-mediated conversion of boreal forest to temperate forest and the loss of favorable snow conditions could occur at a rate and extent that would result in a lower probability of persistence than the median most likely estimate provide by experts, including the possibility that resident lynx could be extirpated from this unit by the end of the century.

Unit 3 - Northwestern Montana/Northeastern Idaho: As in other units, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Fire- and insect-related habitat losses would likely be temporary, resulting subsequently in improved habitat conditions when impacted areas regenerate the dense vegetative structure conducive to hare abundance. Continued forest management to conserve and maintain the vast

majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Lynx experts felt that future extirpation of lynx from this unit from reduced genetic health or a catastrophic event is unlikely. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Considering the factors above, lynx experts felt this geographic unit has the highest likelihood of continuing to support resident lynx into the future in the near term (year 2025; median probability of persistence > 0.95), at mid-century (median = 0.90), and end-of-century (median = 0.78), despite a declining probability of persistence and greater uncertainty with increasing time from present, as in all units. After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is likely the most secure in the DPS. We conclude that it is very likely to continue to support resident lynx in the short term (through 2025) and through mid-century, although the number of lynx, the amount and distribution of high-quality habitat, and landscape-level hare densities are all likely to decline by mid-century as a result of continued climate warming and associated impacts. We also agree that this unit is more likely than not to support some resident lynx at the end of this century, although at that time we expect lynx numbers and distribution would be substantially reduced from the current condition and would, therefore, be more vulnerable to demographic, environmental, and genetic stochasticity and to catastrophic events, resulting in diminished resiliency.

Unit 4 - North-central Washington: Recent wildfires have temporarily eliminated or reduced the quality of greater than 50 percent of lynx habitat within north Cascades, which has significantly affected the status of and current viability of the lynx population within this geographic unit. Similar to the other geographic units, continued climate warming is anticipated to reduce the future quality and distribution of lynx habitat in Washington, potentially further exacerbating the recent temporary losses of lynx habitat from wildfires. Projected warming may increase wildfire frequency and severity, which may result in further temporary losses of lynx habitat. Climate change is also expected to reduce the quantity and quality of snow, potentially resulting in permanent reductions in the quantity and distribution of lynx habitat in Washington State. These potential climate-driven reductions of lynx habitat may serve to further isolate lynx populations within this unit as well as between neighboring lynx populations in the other geographic units and Canada. Continued forest management on both Federal and State lands will benefit lynx populations in Washington, but this may not completely ameliorate the potential negative effects related to climate change. Considering the recent reduction in lynx habitat and the projected impacts of climate change, experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), mid-century persistence at 30% to 80% (median = 70%), and end-of century (year 2100) persistence probabilities less than 50% (median = 38%) for lynx populations within this geographic unit. After considering the best available scientific information and input from lynx experts summarized above, the Core Team is generally in agreement with the experts regarding the probability of long-term persistence of Canada lynx in this geographic unit. We expect this unit will continue to support a small resident lynx population through mid-century but that its ability to do so beyond then is questionable, and that functional extirpation of lynx from this unit by the end of the century is more likely than not.

Unit 5 - Greater Yellowstone Area (GYA): As elsewhere, climate change is projected to reduce the future amount, distribution, and quality of lynx habitats in this unit via northward and upslope contractions in favorable snow and forest vegetation conditions. This will result in increased fragmentation and isolation of habitats and smaller and more isolated lynx populations. Because potential habitats in much of this unit already are naturally highly fragmented and perhaps only marginally capable of supporting resident lynx, and because it appears to have never supported more than a small number of residents, its ability to do so in the future is tenuous. Lynx experts felt that the small number of lynx this unit appears capable of supporting and its relative isolation from other lynx populations make it more vulnerable to genetic drift and extirpation from catastrophic events or demographic or environmental stochasticity. However, the extent to which the future demographic and genetic health of lynx populations in this unit may be influenced by immigration is unknown. Increased wildfire frequency and extent and perhaps other climate-mediated factors (forest insect outbreaks, changes in northern hare/lynx cycles that may influence immigration into this unit) could also reduce future lynx habitats and populations in this unit. Continued forest management to conserve and maintain the vast majority of lynx habitats in this unit will benefit resident lynx in the future, though it is unlikely to offset the projected adverse consequences of continued climate warming. Considering the factors above, lynx experts felt this geographic unit has the lowest likelihood of supporting resident lynx into the future in the near term (year 2025; median probability of persistence = 0.52), at mid-century (median = 0.35), and end-of-century (median = 0.15), with a declining probability of persistence and greater uncertainty with increasing time from present, as in all units. After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is the least secure in the DPS. We find that conditions for lynx in this unit are naturally marginal, both its historical and current ability to support a persistent resident lynx population are questionable, and that continued climate warming and associated impacts are likely to further diminish its already limited ability to support resident lynx. We conclude, based on the protected status (national park, designated wilderness, and non-developmental land use allocations) of vast areas and climate models that project some areas of adequate vegetation and snow conditions through the end of the century, that this unit may continue to occasionally/ intermittently support a small number of resident lynx and some reproduction throughout the remainder of the century. However, we conclude that it is very unlikely to support a persistent resident population over the short-term (through 2025), even less likely that it will do so at mid-century, and it is highly improbable that this geographic unit will support resident lynx by the end-of-century.

Unit 6 - Western Colorado: Regulatory mechanisms that provide for the conservation of lynx in Colorado consist of State regulations prohibiting unauthorized take of lynx and amendments of USFS and BLM management plans, which limit vegetation management (among other things) covering approximately 85-90 percent of the lynx habitat within this geographic unit, and provide guidance to limit habitat fragmentation. Climate change is expected to negatively affect vegetation and influence snow conditions within the Western Colorado unit. The elevation gradient in Colorado may provide refugia from deteriorating snow quality, depth, and duration throughout the period. However, climate models suggest a 40 percent decline in snow

persistence. Assuming that snow levels will increase in elevation, lynx habitat is likely to become more fragmented by areas that no longer retain appropriate snow conditions and vegetation. However, we anticipate large areas of snow persistence to remain through the end of the century. Beetle kill and wildland fire will result in temporary nonfunctional habitat conditions. However, affected areas are likely to regenerate and provide excellent habitat conditions to support hares and lynx. A caveat to future habitat conditions in light of climate warming is that some areas that currently support snowshoe hare populations may experience vegetation type conversion that may not support snowshoe hares. Our conclusion, based on the information available to us, is that lynx are likely to persist in western Colorado to the end of the century. Our conclusion is not without uncertainty, stemming primarily from the historical lack of evidence of consistent lynx presence within Colorado prior to the reintroduction effort. Our conclusion is generally consistent with that of the experts.

Table 5, below, summarizes expert predictions of future lynx persistence and Core Team summary of factors thought likely to influence the future resiliency of lynx populations in each geographic unit.

Table 5. Expert-predicted future (2050 to 2100) persistence of lynx populations in individual geographic units of the Canada lynx DPS and supporting evidence and uncertainties.

Lynx population	Lynx expert probability of persistence	Key evidence	Uncertainties
Unit 1 Maine	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	• 50% decline in habitat expected by 2032, habitat will shift to the south edge of range • Slight recovery of habitat by end of century depending on forestry trends • Continued demographic and genetic connectivity to southern Quebec, New Brunswick populations • Climate models predict deteriorating snow quality, depth and duration below thresholds for lynx; more severe than other units • Little elevation refugia	• Future forest management trends and habitat conditions on private forest lands in Maine and Canada • Future shifts in land ownership, forest products markets, and development • Extent and pace of deteriorating snow conditions • Response of hares (pelage mismatch), bobcat and fisher to changing snow regime • Extent and pace of loss of spruce-fir • Future trends in hare populations • Disease and parasites in lynx • Effects of lynx trapping in Quebec
Unit 2 Minnesota	2050 median 80% (range 35 to 100%) 2100 median 35% (range 0 to 100%)	• Smaller population could be susceptible to stochastic effects • Habitat conditions on national forests will remain stable or improve if managed for softwoods • Continued demographic and genetic connectivity to southern Ontario populations	• Future forest management trends and habitat conditions on private forest lands in Minnesota and Ontario • Extent and pace of deteriorating snow conditions • Response of bobcat and fisher to changing snow regime

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		• Climate models predict deteriorating snow quality, depth and duration below thresholds for lynx • Little elevation gradient: lake-effect snow may retain refugia to 2050 but not 2100	• Rate of decline of spruce-fir • Future trends in hare populations • Disease and parasites in lynx
Unit 3 Northwestern Montana	2050 median 90% (range 40 to 100%) 2100 median ~78% (range 10 to 100%)	• Some habitat loss from increased wildfire, otherwise habitat will remain stable with USFS management • Continued demographic and genetic connectivity to southern British Columbia populations • Potential high elevation buffer against climate change • Recent loss of small sub-metapopulation in Garnet Range • Increasing fire frequency	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks • Extent and pace of deteriorating snow conditions • Response of bobcat, pumas, coyotes to changing snow regime • Extent and pace of elevational migration of spruce-fir • Mismatch in elevation between appropriate snow regime for lynx and spruce-fir • Future trends in hare populations
Unit 4 North-central Washington	2050 median 70% (range 10 to 100%) 2100 median ~38% (range 0 to 90%)	• Habitat and population low because of recent fires; could be susceptible to stochastic effects • Continued demographic and genetic connectivity to southern British Columbia populations • Elevation is not sufficient to provide long-term refugia from deteriorating snow quality, depth, and duration	• Extent and frequency of fire in hare-lynx habitat • Extent and frequency of insect outbreaks • Extent and pace of deteriorating snow conditions • Response of bobcat, pumas, coyotes to changing snow regime • Extent and pace of elevational migration of spruce-fir • Future trends in hare populations
Unit 5 Greater Yellowstone	2050 median 35% (range 0 to 90%) 2100 median 15% (range 0 to 90%)	• Habitat loss from 1980s wildfire, otherwise habitat will remain stable with USFS and NPS management • No connectivity with Canada populations; little immigration from DPS populations • Elevation may provide refugia from deteriorating snow quality, depth and duration • Low quality habitat; dry; low hare populations • Smaller population could be susceptible to stochastic effects	• Will habitat support adequate landscape hare densities to support lynx? • Extent to which GYA remains demographically isolated from other DPS populations; immigration from Colorado population • Extent and frequency of insect outbreaks • Extent and pace of deteriorating snow conditions • Response of bobcat, pumas, coyotes to changing snow regime • Extent and pace of elevational migration of spruce-fir • Future trends in hare populations • Extent to which high elevation may provide climate and snow refugia • Extent to which area will be

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			repopulated by the north and/or the south
Unit 6 Western Colorado	2050 median 80% (range 20 to 100%) 2100 median 50% (range 0 to 100%)	• Habitat loss from increased wildfire and insect outbreaks, otherwise habitat will remain stable with USFS management • Isolation from other lynx populations • Elevation may provide refugia from deteriorating snow quality, depth and duration • Uncertainty about stability of recently-reintroduced lynx population	• Demographic and genetic effects of isolated population • Extent and frequency of fire in hare-lynx habitat • Extent and frequency of future insect outbreaks • Extent and pace of deteriorating snow conditions • Response of bobcat, pumas, coyotes to changing snow regime • Extent and pace of elevational migration of spruce-fir • Mismatch in elevation between appropriate snow regime for lynx and spruce-fir • Future trends in hare populations

5.2 Future Conditions - Detailed Descriptions by Geographic Unit

5.2.1 Unit 1 - Northern Maine

Expert Projections of Lynx Persistence

Most of the experts that we consulted indicated an initially high and subsequently declining probability of persistence of resident lynx in Maine through the end of the century, with uncertainty (range between lowest and highest probabilities) also increasing over time (Lynx SSA Team 2016, pp. 33-36 and Fig. 8, below). Climate change was an overriding near- and long-term stressor for lynx expressed by lynx experts.

Increased winter precipitation in the form of rain, reduced snow depth, and reduced snow durations were discussed by the experts. Experts believed that the effects of climate change would continue to increase as a stressor that would reduce lynx populations by mid- to the end of the century (2050, 2100). Snow conditions would continue to deteriorate (especially in the Northern Maine Unit compared to other areas in the DPS), likely resulting in increased competition with bobcats and increased predation by fisher. We heard varying prognoses from experts regarding the speed at which climate-induced loss of spruce-fir forest will occur. The scientific literature suggests that loss of spruce-fir could occur relatively quickly in the Northeast (but possibly more slowly elsewhere in the DPS) and all noted that an increase in northern hardwood composition of the forest is already occurring. One expert provided information that suggests that balsam fir could actually increase in the short term (next few decades), but that the long-term prognosis is not favorable for natural spruce-fir regeneration. Decline or loss of

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spruce-fir could be accelerated by forest disturbance (budworm outbreak, forest management affecting large acreages of lynx habitat annually).

In addition to climate change, the lynx experts that we consulted expressed a number of near-term stressors (in the next 15 years) related to forest management in northern Maine. Land management objectives were uncertain because of frequent changes in private forest land ownership. Changes in forestry management because of the Maine Forest Practices Act (shift to partial harvesting, increasing acreage harvest, habitat shifting to south) would result in increased fragmentation and declining lynx and snowshoe hare habitat (succession of previous clearcuts from young, dense regenerating stands to mature stands less conducive to high hare densities).

Both the Core Team and experts that we consulted acknowledge uncertainty concerning the severity and response by new landowners to the next spruce budworm outbreak. Experts believed that investment landowners would not respond to the pending spruce budworm outbreak like they did in the 1970s (extensive clearcuts, herbicide application). Experts also acknowledged concerns about the effects of the current clearcuts aging past conditions that support hares and lynx. The Core Team echoes these concerns. We conclude that it is unlikely that the response to the coming spruce budworm outbreak will create extensive hare and lynx habitat as it did in the past.

The best available science indicates that hare populations have declined by about half across all stand types (and in adjacent Quebec) since 2006 and apparently have not rebounded. In response, lynx initially had lower reproduction (lower proportion of females breeding, slightly lower litter sizes), but this has not affected home range sizes. Lower landscape hare densities are likely to eventually result in lower lynx populations. The lynx experts that we consulted were uncertain about how hare numbers will cycle or fluctuate in the future.

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of spruce-fir, and bobcat competition are likely to reduce the probability of lynx persistence in this unit. Modeling of current lynx habitat and future habitat trends was more advanced for the Northern Maine Unit than other units. Models indicate that aging of past clearcuts and changes in forest practices to partial harvesting will diminish the current lynx habitat by half in coming decades. Experts and the Core Team expressed uncertainty about the severity of a pending spruce budworm outbreak, forestry response by investment company landowners, and how this will affect future lynx habitat. More is known about long-term trends in snowshoe hare populations in this unit than others. Hares seem to have declined by half since about 2006 and have remained low. Experts and the Core Team were uncertain about whether hare numbers would rebound or remain at this lower level, but lower hare densities are affecting demographics (especially percentage of females breeding), which could contribute to population declines. Taking all of these factors into consideration, the median probability of persistence projected by the experts to the years 2025 was greater than 95 percent, to 2050 was about 80 percent (range from 20 to 100 percent), and to 2100 was about 50 percent (range from 0 to 100 percent;

Lynx SSA Team 2016, pp. 33-34, Fig. 8). The USFWS lynx Core Team generally agreed with this prognosis with the exception that some were less optimistic about the persistence of this population, especially after reviewing the literature pertaining to climate change in this region.

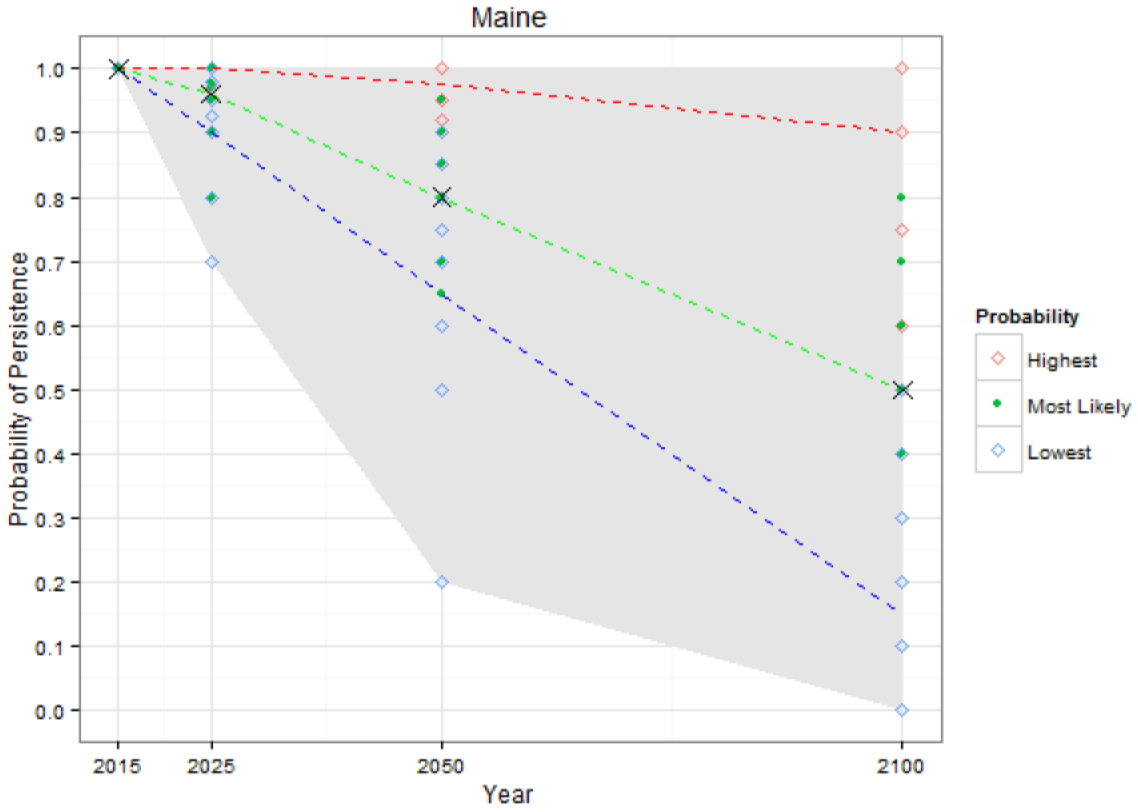


Figure 8. Lynx expert estimates of the probability that the Northern Maine Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Note: In Figure 8, above, and similar figures for the other geographic units, below, points for each of the 10 expert responses, for each of the three probability-of-persistence levels, i.e., highest, most likely, and lowest probabilities of persistence, are represented by the hollow red, filled green, and hollow blue points respectively. The black x mark is the median of the most likely responses across the experts in each response year. The red, green, and blue dashed lines connect the median of the highest, most likely, and lowest probability of persistence responses across the experts in each response year. The edges of the grey area were defined by the extreme responses, i.e., the range from the largest of the highest probability of persistence responses to the smallest of the lowest probability of persistence responses. The median lines and grey area are provided as a summarizing visualization to aid comprehension of the experts' responses and their range, and should not be viewed as a substitute for individual responses or presented outside the context of the accompanying discussion.

<u>Service Evaluation of Factors Potentially Influencing Future Conditions</u>

Regulatory Mechanisms - In response to public concern about widespread clearcutting in northern Maine, in 1989 the Maine Legislature passed the Maine Forest Practices Act (MFPA). The MFPA regulates maximum size of clearcuts (250 acres), separation zones between clearcuts, harvest plans, and notification to the Maine Forest Service. Clearcuts are not banned, but require varying levels of State permits depending on their size. As a result of these regulatory requirements, the number and acreage of clearcuts completed annually has declined substantially and have been replaced by various forms of partial harvesting (Sader *et al.* 2003, p. 349-350; McWilliams *et al.* 2003, p. 35). In the first decade following passage of the MFPA, the percentage of acreage clearcut annually in Maine declined from 40 percent to four percent (Simons 2009, pp. 45-46). The average size of clearcuts has been reduced from >125 acres (Maine Forest Service 1995, entire) to <25 acres (Maine Forest Service 2003, entire; 2005, entire; 2007, entire). Currently, partial harvesting comprises about 94 percent of acres cut annually in Maine (Simons 2009, p. 50). The total volume harvested, however, changed relatively little. The partial harvest that replaced clearcuts include a variety of silvicultural treatments, including both even-aged (e.g., shelterwood) and uneven-aged (e.g., selection) management that result in a wide range of residual stand conditions (Robinson 2006, pp. 5-37), which have important implications for lynx conservation. Foremost, snowshoe hare densities in partially harvested forests are on average about 50 percent lower (but range from 20 to 90 percent lower) than in regenerating conifer stands created by clearcutting (Robinson 2006, pp. 5-37; Scott 2009, p. 109, Simons 2009 p. 83), thus reducing landscape hare density and presenting a challenge for future lynx conservation (Simons 2009, pp. 206, 209, 217; Simons-Legaard *et al.* 2016, p. 7-8; Simons-Legaard 2016, entire).

To harvest the same volume of wood annually, landowners must partial harvest many more acres than they would under former clearcutting silvicultural systems. The acres of forest harvested annually in Maine have increased from about 250,000 acres pre-MFPA to 550,000 acres post-MFPA (McWilliams *et al.* 2003, p. 35). Currently, 27 years after implementing the MFPA, much of the 10 million-acre northern Maine landscape has been partially harvested – some areas being partially harvested on multiple occasions. Extensive partial harvesting and aging of the spruce budworm-era clearcuts have and will continue to reduce landscape hare densities (Simons-Legaard *et al.* 2016, 9-10). If the current landowners continue to harvest using similar methods at and similar rates, habitat for lynx will diminish by about 50 percent by 2030 (Simons-Legaard 2016, pp. 9-10). After 2030, projected outcomes for lynx habitat become more uncertain and depend on assumptions about habitat definitions and harvest rates. Lynx in Maine selected for regenerating, conifer-dominated forest (>75 percent conifer, Vashon *et al.* 2008b, pp. 1490, 1492-1494). If one defines lynx habitat as stands having greater than 75 percent spruce-fir, then habitat will decline by about 50 percent by 2030 and remain at about at this level through 2060 (Simons-Legaard 2016, pp. 9,16).

These projections do not consider the effects of the next outbreak of spruce budworm. After being low for the last 20 years, spruce budworm numbers are again building toward epidemic levels in Maine, southern Quebec, and northern New Brunswick. Significant defoliation in Maine is expected in the next few years and the outbreak may last for about a decade (Wagner *et al.*

2016; pp. 12-16). Although Maine research has clearly demonstrated that landowner response to the last outbreak resulted in unintended, positive benefits for lynx from one to three decades later, our ability to project what effects the next outbreak will have on lynx habitat is still limited. Land ownership has changed dramatically since the last outbreak. To reduce risk from spruce budworm, some financial investment owners may cut younger spruce-fir stands that still support elevated hare populations. Some may be less inclined to intensively manage for spruce-fir and may switch to an emphasis on northern hardwoods. It is unlikely that current landowners will use widespread use of pesticides to control spruce budworm and herbicides to promote spruce-fir regeneration after stands are defoliated. The MFPA may serve as an additional constraint on motivation to clearcut infested stands, even with recently-enacted changes intended to reduce the regulatory burden for landowners. Landowner response to the pending outbreak will have important implications for the short- and long-term persistence of lynx habitat in the northern Maine unit (Simons-Legaard 2016, pp. 16-17).

Nor do these projections consider a substantial decline in snowshoe hare densities that has occurred in Maine. Snowshoe hare density declined by 69.3 percent from a period of high hare density in 2001-2006 (average of 2.1 hares/ha in regenerating conifer) to a period of lower hare density 2007-2009 (average of 1.0 hares/ha). This decline occurred across all forest stand types and across a broad geographic area of Maine (Scott 2009, p. 36) and the adjacent Gaspe region of southern Quebec (Assells *et al.* 2007 *in* Scott 2009, p. 41-42). Hares remained at these lower numbers through 2013 (D. Harrison, University of Maine, unpublished data). If future hare populations remain low, then Maine habitats will have a lower capacity for supporting lynx.

Climate Change - The northern Maine unit is more vulnerable to snowpack loss because of the lack of elevational refugia (Siren *in* Lynx SSA Team 2016, pp. 15 and experts p. 37) and changes in snow conditions could further restrict their range (Hoving 2002, pp. 27-28; Hoving *et al.* 2005, p. 749; Carroll 2007, entire). Wildlife experts in Maine ranked lynx as highly vulnerable to climate change (>66 percent loss in species range/population and extirpation within 50 to 100 years; Whitman *et al.* 2013, pp. 19, 74). Similarly, Carroll (2007, entire) modeled Maine lynx population assuming non-cycling hare populations and snow conditions expected under intermediate to high emissions climate models (Kiehl and Gent 2004, entire). He predicted a 59 percent decline in the lynx population (the non-cycling hare population model) by mid-century because of climate change alone. Maine lacks elevational refugia for lynx under reduced snow scenarios (Carroll 2007, p. 1102), except for the mountains in western Maine where snow refugia may only persist as very small, isolated “sky islands” that would be unlikely to support lynx.

Climate change is already affecting the Northeast, and the rate of change is faster than expected with large changes observed since 1970 (Rustad *et al.* 2014, p. 6). Rapid winter warming in recent decades is believed to be caused by reduced albedo feedback caused by the diminished persistence of snow in winter (Hayhoe *et al.* 2006, p. 25). Average winter temperatures are increasing 0.42-0.46º C/decade with the greatest warming occurring in the coldest months of winter (January, February; Burakowski *et al.* 2008, p. 1). Northeast climate

models predict average winter temperature increasing 2.0ºC (low emission) to 2.9ºC (high emission) by mid-century and 3.1ºC (low emissions) to 5.3ºC (high emissions) by late century (Notaro *et al.* 2014, p. 6529). Largest increases in temperature are expected in northern Maine (A. Siren *in* Lynx SSA Team 2016, Appendix 3; Rawlins *et al.* 2012, p. 9) where temperatures may increase 4.5 to 5.0º F by 2050 (Fernandez *et al.* 2015, p. 3). In response to climate change, interest in wind development has grown in northern and western Maine, increasing threats to high elevation and potential spruce-fir refugia (Publicover 2013, p. 2). Climate conditions are currently at or falling below threshold values needed to support lynx in Maine.

If future trends in increasing temperature and decreasing snow occur, then lynx are unlikely to persist in Maine. Gonzalez *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007) and predicted loss of forest and snow conditions able to support lynx in Maine by the end of the century. Although there are uncertainties about future climate warming, lynx populations in Maine are expected to recede northward and decline substantially this century (Vashon *et al.* (2012, p. 60).

Snow Duration - The current average snow duration in Maine is at or below the 4-month snow persistence threshold believed necessary to support lynx (section 4.1.1; Gonzalez *et al.* 2007, entire) and is projected to decline. Snow duration is projected to continue to deteriorate. Snow duration declined by 16 days in the Northeast from 1970 to 2001 (Wake 2005, p. 15) and is expected to diminish by another two weeks in Maine by mid-century (Fernandez *et al.* 2015, p. 10). Snow duration is expected to diminish by 25 percent (low emissions) to 50 percent (high emissions) from current conditions by the end of the century (Hayhoe *et al.* 2006, pp. 21-25). Similarly, Notaro *et al.* (2014, p. 6543) projected an average decrease of 28 days (low emission) to 47 days of snow cover (high emissions) by the end of the century.

Snow Depth - The current average snow depth in northern Maine is at or below the 270 cm/yr. (106 in/yr) thresholds believed needed to support lynx (section 4.1.1; Hoving *et al.* 2005, p. 749) and is expected to decline. By the end of the century, large areas of the Northeast will experience 15-percent (low emission) to 25-percent (high emissions) reduced snowfall (Ning and Bradley 2015, p. 6). Northeast winter snowfall has decreased by about 4.6 cm/decade, with the greatest decreases occurring in December and February (Hayhoe et al. 2006, p. 1). By the end of the century Notaro *et al.* (2014, p. 6529) projected average snow declines in the North Atlantic Landscape Conservation Cooperative of 59 cm (31 percent) (low emissions) to 92 cm (48 percent) (high emissions) because a higher proportion of winter precipitation will fall in the form of rain rather than snow.

Snow Quality -_Winter precipitation in Maine is likely to increase by 10 to 15 percent by the end of the century (Hayhoe *et al.* 2006, p. 28) with a greater proportion of winter precipitation falling as rain (Huntington *et al.* 2004, entire; Hayhoe *et al.* 2006, p. 23; Ning and Bradley 2015, entire). Snow density and compaction (caused by wet, heavy snow or rain on snow events in winter) will continue to increase in the region in the future (Karl *et al.* 1993, entire; Dudley and

Hodgkins 2002, pp. 8-10, 19-20; Huntington *et al.* 2004, p. 2632; Huntington 2005, entire; Hodgkins and Dudley 2006, entire).

Loss of Boreal Forest - Climate change is projected to cause a northward contraction of spruce-fir forest in the Northeast with potential negative consequences for both lynx and snowshoe hares (Gonzalez *et al.* 2007, entire). Spruce-fir forest is expected to decline substantially in Maine and the Northeast (Ollinger *et al.* 2008, p. 17; Beckage *et al.* 2008, entire; Jacobson *et al.* 2009, p. 27; Tang and Beckage 2010, entire; Whitman *et al.* 2010, p. 12) or disappear (Iverson and Prasad 2001, pp. 192-193; Prasad *et al.* 2007, entire) because of climate change. Climate change is anticipated to increasingly fragment the boreal forest in northern New England (Iverson *et al.* 2008, pp. 400-405). Lynx habitat will decline as boreal forest diminishes (Simons 2009, pp. 221-222). Even under the lowest emissions scenarios, spruce-fir forest would be reduced by 2100 (Williams and Liebhold 1997, pp. 210-214; Prasad *et al.* 2007, entire; Mohan *et al*. 2009, pp. 221-222), although some spruce-fir may persist at highest elevations (Tang and Beckage 2010, pp. 148-156) and along the eastern coast (Jacobson *et al.* 2009, pp. 26-29) where cooler conditions will prevail. Recent shifts of northern hardwoods to higher elevations formerly occupied by boreal forests have also been attributed to regional warming over the last century (Beckage *et al*. 2008, entire).

The spruce-fir forest type has come and gone from New England during the post-glacial period. It nearly disappeared from the Northeast during the interglacial warming period 1000 years ago, then moved south into New England only in the past few centuries during the “Little Ice Age” (Schauffler and Jacobson 2002, entire; DeHayes *et al.* 2000, entire). Because of its sensitivity to climate and mobile nature, Iverson *et al.* (2008, p. 403) predicted a significant decline (low emissions) or the disappearance (high emissions) of the spruce-fir forest type in northern Maine in response to climate change.

Spruce (red, black, white) and balsam fir are the most important boreal forest conifer tree species in the Northeast and will be affected by climate change in different ways. Mechanisms of injury to spruce-fir include winter injury from freeze-thaw cycles, spring drought (because of reduced snowpack), and reduced seed germination (Auclair *et al.* 2010, pp. 694-695). Thus, the range of spruce-fir is limited by summer heat and drought. Mohan *et al.* (2009, p, x) projected that suitable area for balsam fir would decline by 80 percent in 2100 under an average to high emissions scenario. In contrast, Ollinger *et al.* (2008, p. 8) projected increasing growth rates for balsam fir and red spruce to mid-century, after which they would decline.

The timescale of the spruce-fir decline in the Northeast is difficult to predict because of the many variables that influence shifting of the forest species composition (emissions scenarios, the long lifespan of trees, slowness of tree dispersal, frequency of disturbance, competition from advancing hardwoods and invasive tree species, complex interactions with moisture, and synergistic effects with other pollutants). Arguments in favor of an accelerated decline include evidence that spruce-fir is already in decline and is being replaced in Maine by northern hardwoods (oak, pine, red maple). Since 1995, the area of forest land classified as the northern hardwoods type in Maine has increased 8.9 percent (by about 2,400 km^2 [927 mi^2]) and the area

in the spruce/fir forest type group has decreased 8.5 percent (1,987 km^2 [767 mi^2]) (McCaskill *et al.* 2016, p. 2).The decline of the spruce-fir forest type may be accelerated by forest disturbances when northern hardwoods replace areas formerly occupied by spruce-fir. In some situations, disturbance may favor persistence of balsam fir and help it persist longer in a warming climate (Scheller and Mladenoff 2005, p. 318). A pending spruce budworm outbreak and frequent disturbance from forest management could accelerate conversion to northern. Other climate-related forest disturbances (forest pests, diseases) could further accelerate conversion to northern hardwoods (Iverson *et al.* 2008, p. 404).

In contrast, some authors note that trees migrate slowly in response to a changing climate and are long-lived. Therefore, a time lag may occur in shifting forest composition from spruce-fir to northern hardwoods (Mohan *et al.* 2009, p. 221; Zhu *et al.* 2012, pp. 1048-1051). Some northern Maine industrial forest landowners could "adapt" to climate change by intentionally favoring spruce-fir (e.g., by plantations and use of herbicides).

Finally, there is uncertainty concerning the influence of climate change on balsam fir, a short-lived, shade-tolerant, conifer that dominates much of the understory in the Acadian forest and is an important component of lynx habitat in the Northern Maine Unit. McWilliams *et al.* 2005 (p. 8) noted that balsam fir increased in Maine's forest inventory in the early 2000s because this species seems to respond favorably to frequent disturbance. Forest models projected increases in spruce-fir biomass over the next century because of partial harvesting and periodic budworm outbreaks, but did not take climate change into consideration (Simons-Legaard *et al.* 2013, entire). In contrast, Iverson *et al.* 2008 (p. 400) identified balsam fir as the most sensitive tree species in Maine to a warming climate, and they projected large declines, with only 29 percent (low emissions) to 16 percent (high emissions) persisting by the end of the century. Climate change will influence precipitation and temperature, forest management strategies, and forest disturbance (fire frequency and spruce budworm), all of which will interact in complex ways to influence balsam fir at the southern edge of its range. Carter (1996, pp. 1092-1093), Iverson *et al.* (1999, pp. 400, 403), and Goldblum and Rigg (2005, p. 2714) documented balsam fir growth rates and growth potential would decline under likely climate warming scenarios (~4 to 5 F degree temperature increase by the end of the century and reduced snow conditions). Some have projected the extirpation of spruce-fir forest types in the Great Lakes States (Scheller and Mladenoff 2005, entire) and New England (Iverson and Prasad 2000, p. 403). Balsam fir has prolific seed production following forest disturbance such as harvesting (Seymour 1992, p. 217), and has proliferated under the current climate and forest management regime dominated by partial harvesting (Olson *et al.* 2013, entire). Balsam fir is a relatively short-lived tree (~100 years), and is unlikely to persist long if climate change affects seed and germinations rates. Given, anticipated climate changes, especially early snow melt and low spring precipitation, fir may increase for the next few decades but is unlikely to regenerate in a the future Maine forest (E. Simons-Legaard, University of Maine, *pers. comm.* May 31, 2015).

Vegetation Management - Habitat suitable for lynx is expected to decline in the future (see Regulatory Mechanisms section above). By 2020, all of the extensive areas that were clearcut in the 1970s and 1980s will be greater than 35 years of age and no longer support high hare

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densities. For the foreseeable future, partial harvesting will continue as the primary means of forest management. Although partially harvested forests with well-developed understory structure may provide foraging opportunities via increased prey access (Fuller *et al.* 2007, 1984-1985), snowshoe hare densities are approximately 50 percent less in landscapes dominated by partially harvested stands (Robinson 2006, pp. 5-37; Fuller and Harrison 2010, p. 1276). Thus changing forest management practices have and will continue to reduce landscape hare density possibly below levels that can support lynx.

Sources of uncertainty concerning future habitat conditions in northern Maine include changes in forest policy, timber harvesting methods, changing timberland ownership, response to budworm outbreaks, and timber markets - all of which have occurred in the recent past and will undoubtedly shape forest management in the future (Simons-Legaard *et al.* 2016, p. 8). Currently, the landscape is owned primarily by financial investors who may be less inclined to intensively manage for spruce and fir after the next outbreak of the spruce budworm (Wagner *et al.* 2016, p. 4).

The dramatic shift from clearcutting to partial harvesting presents a challenge for lynx conservation in this unit for the next several decades. Lynx, habitat is expected to peak and then remain stable through about 2012-2020 then decline (Simons 2009, pp. 153-165, 202-220; Simons-Legaard *et al.* 2016, p. 6). After 2020, aging of the former clearcuts and extensive partial harvesting are projected to result in a 50 to 65 percent decline in lynx habitat by 2032 (Simons 2009, p. 217). Lynx habitat will decline from about 9.5 percent of the landscape (current condition) to about 5.0 percent of the landscape (Simons-Legaard 2016, Fig. 8, p. 10). By 2032, the Northern Maine Unit may support less than half the number of resident lynx that it does today (Simons 2009, pp. 209, 217).

In the future, lynx habitat will be fragmented into smaller, isolated parcels, and will shift southward into areas occupied by bobcats and fishers where snow conditions are unlikely to favor lynx (Simons 2009, pp. 153-165; Simons-Legaard *et al.* 2016, pp. 1, 6; Simons-Legaard 2016, p. 8). By 2022, the number of patches of high quality hare habitat will increase by 57 percent, but the average size of patches will decline by 87 percent, and patches will become more isolated (Simons-Legaard *et al.* 2016, pp. 5-6). The proximity index of high quality habitat patches will decline by 78 percent within lynx home ranges. Although lynx habitat is peaking, fragmentation may diminish its ability to support lynx (Simons-Legaard *et al.* 2016, p. 8).

Beyond 2030 assumptions concerning future climate change, land ownership, and harvest rates introduce greater uncertainty. The most optimistic forest management models (greatest harvest rates, no climate change, no spruce budworm) project that lynx habitat will decline over the next few decades then gradually increase to about 10 percent of the landscape by 2060 (Simons-Legaard 2016, Fig. 8, p. 9). The most pessimistic models (lowest harvest rates, no climate change, no spruce budworm) project about 5 percent of northern Maine will have high quality hare habitat from 2030 to 2060 (Simons-Legaard 2016, Fig. 8, p. 9), although the habitat will be much more fragmented and have smaller patch sizes (Simons-Legaard *et al.* 2016, entire).

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Softwood plantations could offset losses in spruce-fir and become a form of adaptation to climate change effects of reducing spruce-fir forest types. Jack pine plantations are extensive in adjacent New Brunswick (Etheridge *et al.* 2005, p. 1966). A forest company that has planted extensive spruce plantations in New Brunswick recently purchased nearly 1 million acres (4,047 km^2 [1,563 mi^2]) of forestland in northern Maine where it is doing the same. Spruce plantations are becoming more common on this ownership in Maine, but not others. Stand structure and intensive management of plantations are highly variable (e.g., pruning, thinning, herbicide treatments), thus hare density and use by lynx vary (Roy *et al.* 2010, entire). Hares can achieve higher densities in plantations depending on the amount of lateral cover, but for shorter periods of time; ~10 to 17 years after cutting and planting in New Brunswick (Parker 1984, p. 163) and 15 to 25 years in Quebec (Roy *et al.* 2010, p. 585). This is in contrast to ~15 to 35 years in naturally regenerating spruce-fir stands after harvest (Simons-Legaard *et al.* 2016, p. 4). The future of plantations in the northern Maine unit is uncertain. Most investment landowners have short-term investment horizons and are unlikely to invest in plantations.

Natural stand-replacing disturbances are rare and infrequent and, other than spruce budworm outbreaks, are unlikely to significantly affect future habitat conditions (Hoving *et al.* 2004, p. 292). A spruce budworm outbreak is projected to reach epidemic proportions in Maine in 2018 to 2021. The epidemic has already affected 10 million acres (40,470 km^2 [15,630 mi^2]) of spruce-fir in southern Quebec, immediately north of Maine (Wagner *et al.* 2014, entire). The last outbreak in the 1970s and 1980s killed millions of acres of spruce and fir forests in the Northern Maine Unit. Maine's 5.8 million acres (23,472 km^2 [9,063 mi^2]) of spruce-fir stands across the State are at risk of defoliation. Although the outbreak has caused severe defoliation thus far over 15 million acres (60,703 km^2 [23,438 mi^2]) of spruce-fir forests in southern Quebec, some project a weaker outbreak in Maine because spruce and fir trees are younger and less susceptible and there is a higher hardwood component in northern Maine forests (Wagner *et al.* 2016, p. 18-22). A typical outbreak lasts for a decade.

Forest management strategies for addressing the coming outbreak vary and include applying insecticides (although land area sprayed is expected to be small compared to the previous outbreak), pre-emptive cutting of mature spruce-fir before defoliation, stop precommercial and commercial thinning, and salvaging dead and diseased trees (Wagner *et al.* 2016, pp. 38-48). An aggressive forest management response (or not) will greatly affect future outcomes for lynx habitat (see section 5.2.1). The next budworm outbreak and subsequent forestry response is a disturbance agent that may accelerate changes in forest composition influenced by climate change, especially toward increased northern hardwood and reduced spruce-fir. The nature of land ownership is greatly changed from the 1970s and 1980s, and landowner response is expected to be diverse depending on their objectives and investment horizons. The pending budworm outbreak cast additional uncertainty on the status of lynx habitat beyond 2030.

Climate change, forest management and budworm outbreaks will interact to influence the future trajectory of spruce-fir forest in Maine. All three variables have yet to be modeled simultaneously (K. Legaard 2016, *pers. comm.*). Assuming current forest management trends persist to the end of the century, spruce-fir dominated forest is expected to continue to decline

(Legaard *et al.* 2013, entire). The combination of budworm-induced mortality and salvage harvesting will have a negative effect on spruce-fir (Legaard *et al.* 2013, entire). However, after a budworm outbreak the biomass and area of mixed-hardwood/softwood forest would be expected to increase through this century primarily because of the proliferation of regenerating balsam fir (see discussion above) (Legaard *et al.* 2013). Mixed forests having a high (greater than 50%) hardwood component are not believed to support high hare densities (Scott 2009, p. 109) or be preferred by lynx (Vashon *et al.* 2008b, pp. 1492-1493). It is uncertain whether lynx can adapt to lower landscape hare densities associated with mixed hardwood-softwood forest. They may persist, but at lower densities as they currently do in the western units of the DPS. However, the probability of persistence is further diminished by deteriorating snow conditions and increased populations of bobcats and other competitors.

Wildland Fire Management - Susceptibility of the northern Maine unit to fire may be enhanced by a severe spruce budworm outbreak because of the amount of dead and dying spruce-fir (Stocks 1987, entire), although there were no large fires after the last outbreak. Fire risk is currently very low in this unit and a continuous decrease in fire frequency is predicted with climate change in eastern Canada because of increased precipitation and decreased drought (Bergeron and Flannigan 1995, entire; Flannigan *et al.* 1998, entire). Climate is expected to become more variable (i.e, wider extremes of summer drought and precipitation) during the next century (Gregory & Mitchell 1995, entire; Gregory *et al.* 1997, pp. 684-685), which could create fire conditions in unusually dry years (Flannigan *et al.* 1998, p. 475). Maine's policy is to immediately suppress wildfire, thus large, stand-replacing fires are expected to be infrequent in this region. Notable large fires in Maine include a 3 million-acre (12,141 km^2 [4,688 mi^2]) fire in 1825 and a 200,000-acre (809 km^2 [313 mi^2]) fire in 1947.

Habitat Fragmentation - The future of the 10 million-acre (40,470-km^2 [15,630-mi^2]), sparsely populated "North Woods" of Maine is highly uncertain and has been the subject of intense public debate (Baldwin *et al.* 2007, entire). Land use and zoning in the state's "unorganized townships" are the responsibility of the Land Use Planning Commission (LUPC) in the Maine Department of Conservation. The LUPC revised its Comprehensive Land Use Plan (Maine Land Use Regulation Commission 2010, entire), and described principal values in guiding future land management decisions: maintaining working forests, provide for traditional recreational opportunities, protect high-value natural resources, and encourage long-term conservation. The North Woods has long been considered a public resource or "commons," even though privately owned (Judd 2007, p. 9). This land was traditionally owned by a few large timber companies, but since the 1980s there has been rapid turnover in ownership largely by investments companies and subdivision of large parcels (Hagan *et al.* 2005). Financial investors, primarily Real Estate Investment Trusts (REITS) and Timber Investment Management Organizations (TIMOs), focus on maximizing the asset value of timberlands and are increasingly likely to seek revenue from non-timber resources if they generate a higher return. These new owners operate over relatively short time horizons (e.g., 5 to 15 years) and are willing to consider multiple means of monetizing their asset, including development and real estate sales (Legaard 2013, entire). If left unchecked, these pressures may continue to promote dispersed development throughout this region. Parcelization and subdivision has increased, particularly in the southern

third of the jurisdiction (Maine Department of Conservation 2010, p. 72-73). The LUPC has limited ability to address stressors on Maine's North Woods, including resale and subdivision trend. This trend is likely to continue into the foreseeable future and will make management of large, forested landscapes for Canada lynx even more difficult.

Historically, development has stayed mostly on the edges of the North Woods jurisdiction with exception of scattered seasonal dwellings and sporting camps in the interior, but this could change in the future. Between 1971 and 2005, the LUPC permitted 8,136 new dwellings in unorganized townships — an increase of 66 percent in the number of residences during this time period (Maine Land Use Regulation Commission 2010, p.80). Between 1971 and 2005, the LUPC issued 1,353 development permits for new uses scattered throughout the unorganized townships (Maine Land Use Regulation Commission 2010, pp. 97-99); most (42 percent) being recreational facilities (boat launches, campsites, gatehouses, recreational lodges). Most development has occurred in areas that abut organized communities and near public roads. Within the interior most development has occurred on long lakeshores and waterfront. However, the amount of hillside and ridge development is growing and this trend is likely to continue (Maine Land Use Regulation Commission 2010, p. 136), which will further fragment lynx habitat.

We have an incomplete understanding of the effects of outdoor recreation on lynx and their habitat (ILBT 2013, p. 80). Future trends in outdoor recreation in northern Maine are also uncertain (Vail 2007, entire). A portion of the North Maine Woods is a gated road system that encompasses about 3.5 million acres. Visitation by outdoor recreationists is currently about 175,000 per year and declining. Likewise, visitors to Baxter State Park and the Allagash Wilderness Waterway have declined (Vail 2007, p. 107). Aside from a vigorous discussion of the recently-designated Katahdin Woods and Waters National Monument or a master tourism plan for the area (Vail 2007, pp. 112-113), there could be stagnant or declining participation in traditional outdoor recreational activities in the future (Vail 2007, p. 107). Alternately, increased numbers of second homes and resorts could increase visitor numbers in the future. Snowmobiling may be an exception and has risen in popularity in northern Maine, but it too may decline because of declining snow (see climate change section, above). The effects of new or expanded downhill ski development on fragmentation of lynx habitat are expected to be minimal. Three alpine ski resorts occur within the unit on the southern margin of lynx habitat: Saddleback Mountain Ski Area in Sandy River Plantation near Rangeley, Sugarloaf Mountain Ski Area in Carrabassett Valley, and Sunday River Skiway in Newry and Riley Township. Further development of ski areas is unlikely in the Western Maine Mountains. Future trends in outdoor recreation and associated effects on lynx, hares, and their habitat are uncertain in the northern Maine unit

Within the last five years, two landowners developed concept plans for rezoning for large-scale development of hundreds of house lots and resort development within designated lynx critical habitat. Under one concept plan, 975 houses and two resorts would be constructed on about 14 km^2 (5.5 mi^2) and a 1,469-km^2 (567-mi^2) conservation easement would be established. A second concept plan would allow development on about 8 km^2 (3 mi^2) of land and establishment

of a 59-km^2 (23-mi^2) conservation easement. Although these developments have not been built, they may portend future trends in land use.

Energy production is emerging as a potentially significant economic factor in this unit, with grid-scale industrial wind power, solar power, biomass, biofuels, and other energy sources offering new opportunities to utilize natural resources. Wind energy resources are high within the lynx critical habitat (National Renewable Energy Laboratory 2010, http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=mecitation ; last accessed 5/25/2016), and wind development in the lynx critical habitat are likely to accelerate in the foreseeable future. Two large wind energy projects are being considered in designated lynx critical habitat in this unit; if built, each would cover about 450-650 km^2 (180-250 mi^2) and become two of the largest such projects in Maine. Mining is not a traditional land use in this unit, but a large mining operation is being considered at one location in designated lynx critical habitat. Extraction operations for gravel (for road building) are widely-scattered throughout the unit.

The area designated as lynx critical habitat is heavily-roaded, particularly with forestry roads. While accurate numbers are difficult to obtain, approximately 1,500 miles of public roads and over 20,000 miles of private roads exist within unorganized areas of Maine (Maine Department of Conservation 2010). There has been discussion of an east-west limited access highway through northern Maine and extending Interstate 95 north from Houlton to Presque Isle, which, if constructed, would further fragment habitat (Maine Department of Transportation 1999, Beck *et al.* 2012, p. 38).

An increasing area of the designated lynx critical habitat in this unit is likely to be placed under conservation easements that will limit future development and fragmentation of lynx habitat. Maine has the largest amount of land under easement of any state, and there are about 8,094 km^2 (3,125 mi^2) of conservation easements in lynx habitat in northern Maine (Pidot 2011). Continued expansion of areas under conservation easement is uncertain and will depend on willing landowners and funding available for purchase of easements. Conservation easements often purchase development rights, but they may allow for wind power development and other land uses that may not be compatible with lynx conservation. Easements in Maine allow forest management, but they rarely prescribe specific management that would benefit lynx and other species of conservation concern.

The Core Team believes that all development trends portend increased loss and fragmentation of lynx habitat in the Northern Maine Unit. As habitat is lost and fragmented as a result of development, it will become increasingly difficult to influence landscape-scale forest management that could benefit lynx.

Conclusion

After reviewing the scientific literature concerning snow and climate change and acknowledging other threats unique to this unit (e.g., lack of forest planning for lynx, rapid land ownership

turnover and development pressures), the Core Team also believed that the population status of lynx in Maine will diminish substantially in the future. The Core Team believed that lynx populations in Maine are at an artificially (historically) high level and will decrease to lower populations. The Core Team believed that given current trends (diminishing snow conditions, extensive partial harvesting of the forest, forest fragmentation, possible pelage mismatch for hares, increasing populations of bobcat and fishers in a lower snow environment) landscape hare densities have, and will continue to decline in northern Maine. Extended periods of lower hare numbers (as seems to be occurring now), would be expected to exacerbate these declines.

The Core Team concurred with expert assessments concerning trends in forest management, but we also note that development pressures in northern Maine did not receive much discussion at our expert elicitation workshop. We believe that development pressures (residential and commercial development, energy development, transmission lines, roads, mining) will increasingly become competing land uses on private lands in northern Maine. We also expect the rapid turnover and subdivision of private forest lands in northern Maine to continue, which will accelerate opportunities for non-forestry land uses. Turnover in land ownership have provided opportunities to conserve some areas of the north Maine woods through purchase of conservation easements and fee title acquisitions, including a new Katahdin Woods and Waters National Monument. However, conservation easements do not fully protect these lands from some kinds of development that could adversely affect lynx and their habitat. For example, many conservation easements allow large-scale, industrial wind power development. We conclude that various forms of development in northern Maine will continue in the future.

The Core Team believes Maine lynx populations would be expected to decline more rapidly in a future scenario without Federal listing. The lynx is not State-listed in Maine and there is currently little consideration of lynx in the review of projects requiring state permits. There is a closed season on lynx, so intentional take would continue to be prohibited. There is rarely a nexus for Service review of forestry projects under section 7 of the ESA (i.e., no Federal funding or permits are typically required for forest management on private lands). Nevertheless, because of their Federal listing, Canada lynx are a priority species for planning by Federal, Tribal, State, and private forest landowners. Although few private landowners have thus far made formal commitments to intentionally manage their forests for lynx, by virtue of their Federal listing status they at least consider the possibility of doing so in the future. This is particularly true of landowners who must plan for Federal listed species as a requirement of their enrollment in green certification programs. Without Federal listing, there would be no incentive or motivation for private forest landowners to change the current paradigm of partial harvesting and intentionally engage in forest management to benefit lynx. With current Federal listing, there is a nexus for the Service to review other projects in northern Maine (e.g., Army Corps of Engineers permits for wetland impacts); for new highways, transmission lines, large-scale energy development, mining, and residential and commercial development. Without Federal listing, few of these projects would consider lynx. Critical habitat has been an important consideration in the Federal review of the aforementioned kinds of development projects. Critical habitat also has had a positive influence on land conservation in northern Maine, with

land trusts and non-governmental organizations using the lynx and their critical habitat as justification for seeking funds for conservation easements. This justification for habitat protection would no longer be valid in a future scenario without lynx being Federally-listed. The Core Team concludes that a future scenario without Federal listing would result in increased habitat loss and fragmentation and would result in reduced justification for habitat protection initiatives in northern Maine.

Lynx would be at greater risk without ESA section 9 prohibitions against take. In a future scenario without Federal listing, Maine's incidental take plan for trapping would be rescinded, and it is likely that many protective measures to minimize injury, take, and mortality of lynx would cease or diminish. It is unlikely that lynx would become a legally trapped furbearer in Maine (although some Maine trappers have suggested that). Habitat mitigation for lethal take of lynx associated with the Maine trapping HCP would cease. About 10 lynx have been illegally shot and reported or otherwise discovered since listing. Illegal shooting and non-reporting would likely increase without Federal protection. We believe several high-profile Federal law enforcement cases have helped to reduce illegal shooting of lynx. With a diminished snow regime, populations of bobcats would be expected to increase and expand northward into areas currently occupied by lynx. Incidental take of lynx from bobcat trapping, running with dogs, and hunting activities would likely increase without Federal listing. Similarly, increased fisher populations and trapping would be expected to occur in northern Maine in a diminished snow regime that would lead to greater incidental (lethal) take of lynx. There have been a few situations where lynx have destroyed livestock, but lethal actions to remove lynx were avoided because of Federal listing. Without Federal listing, justification for shooting lynx in these situations would likely increase. We believe that despite a closed hunting and trapping season, incidental take would continue and possibly increase and could become a significant threat to a population of lynx that will likely be significantly diminished by mid- to late-century.

After considering the lynx expert opinion and the best available scientific information, the Core Team was more pessimistic than the experts about the probability of persistence of Canada lynx in the northern Maine unit. All threats – forest management, climate change, habitat loss and fragmentation, and development – are increasing in frequency, intensity, and extent. The amount of high quality hare and lynx habitat created by clearcutting in the 1970s and 1980s recently peaked at unprecedented high levels that are unlikely to be achieved again. Because of state regulations, forest management has shifted dramatically away from clearcutting to many forms of partial harvesting, which on average support less than half the hare densities. Forest land ownership has, and continues to rapidly change, further subdividing private forest lands. Furthermore, hare densities have declined by half and have remained at these lower levels. Lynx habitat in the next few decades will shift south to areas that will be more influenced by climate change and northward range expansion by bobcats. Thus, we conclude that the carrying capacity to support lynx is diminishing, and the lynx population will decline as the quantity and quality of boreal forest habitat declines. In contrast to other units, there are no commitments by private forest landowners to management plans to ameliorate this stressor. After reviewing the best available scientific information, we believe that climate change is a significant threat to lynx in the Maine unit; more so than expressed by experts. Deep, fluffy snow

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is critical to the existence of hare and lynx, and snow depth and duration are currently at or below the thresholds believed necessary to support lynx. Unlike other units, as snow condition decline there is little elevational refugia for lynx in Maine. Spruce-fir is being replaced by northern hardwoods because of climate change. Frequent forest cutting and disturbance, including a pending spruce budworm outbreak, could accelerate conversion to northern hardwoods. We acknowledge that the rate of spruce-fir decline is uncertain, but note that some of the science reviewed indicates the spruce-fir forest type could nearly disappear from Maine by late-century under both low and high emissions scenarios. Climate change models portend declining snow conditions from low- to high-emissions. Because increases in temperature are thus far tracking high emissions scenarios we are less optimistic for snow conditions that favor lynx by mid- to late-century. In the past decade, interest in development has increased in lynx critical habitat, especially proposals for large-scale residential and resort development and extensive wind energy development that could cover hundreds of square miles. We conclude that these threats, individually and cumulatively, indicate diminished populations of lynx and their habitat. If these threats are not abated, we believe that the probability of persistence will be lower than projected by experts by mid-century and that lynx will have a greater likelihood of extirpation by the end of the century.

5.2.2 Unit 2 - Northeastern Minnesota

Expert Projections of Lynx Persistence

The experts that we consulted indicated an initially high and subsequently declining probability of persistence of resident lynx in Minnesota, with increasing uncertainty through the end of the century (Lynx SSA Team 2016, pp. 37-38 and Figure 9, below). Near term drivers of the projected decline were reduced quality, quantity, and persistence of snow, competition from bobcats, disease (*e.g.*, lungworm, liver fluke, feline leukemia), and forest insects. Long term drivers of the projected decline were reduced the quality, quantity, and persistence of snow, competition from bobcats, loss of spruce-fir forests, wildfires, and climate change.

Climate change was primarily associated with loss of boreal forest but could potentially also increase disease or insect outbreaks, and is likely to affect the amount of precipitation falling as good quality snow in the area of the state supporting lynx habitat. We heard varying prognoses from experts on the speed at which climate-induced loss of boreal forest will occur. The scientific literature suggests and one of the climate change experts indicated that loss of spruce-fir could occur relatively quickly in the Midwest and Northeast (but possibly more slowly elsewhere in the DPS because of elevational refugia) and all noted that an increase in northern hardwood composition of the forest is already occurring. The connection to lynx in Ontario reduces the likelihood of local extirpation in this geographic unit, but the likelihood would increase if connectivity was compromised.

Although uncertainty increases with time from the present, experts generally agreed that climate-related loss of favorable snow conditions (amount, consistency, and duration), loss of boreal forest, and increased bobcat competition and hybridization are likely to reduce the

probability of lynx persistence in this unit. Experts expressed uncertainty about the severity of a pending insect outbreak (and how this will affect future lynx habitat) and the potential introduction and spread of diseases. Less is known about long-term trends in snowshoe hare populations in this unit than other units (e.g., the Maine unit).

Taking all factors into consideration (i.e., loss of boreal forest, competitions, disease and insect outbreaks, loss of snow), the experts projected the mean probability persistence to the year 2025 was greater than 90 percent, to 2050 was 80 percent (ranging from 60 to 90 percent), and would decline to approximately 35 percent (ranging from 10 to 60 percent) by 2100 (Lynx SSA Team 2016, pp. 37- 38).

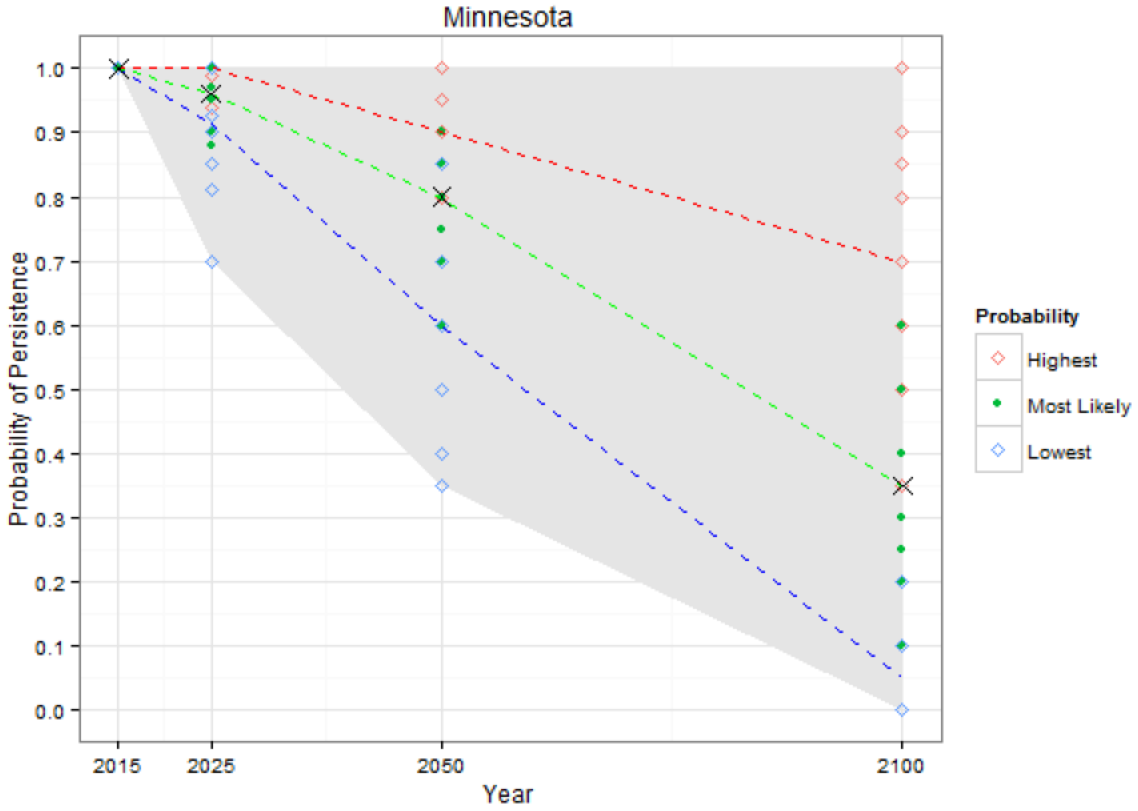


Figure 9. Lynx expert estimates of the probability that the Northeastern Minnesota Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - In Minnesota, the vast majority of lynx habitat that supports a long-term persistent lynx breeding population is administered by the SNF. This area includes designated critical habitat (79 FR 54782). The SNF is currently implementing the 2004 SNF Plan (USFS 2004a, entire), which has direction based on the LCAS (Ruediger et al. 2000, entire) and the Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (USFS and USFWS 2000, entire), for all forest activities that occur within LAUs. Active management of forest lands can maintain, restore, or create lynx habitat, and the SNF has a

long-term commitment to doing so. If the SNF continues to follow vegetation and wildland fire management and other applicable recommendations under the 2000 LCAS (or the updated 2013 LCAS or subsequent updates) in its Forest Plan, we expect that several risk factors will continue to be minimized and managed to promote the conservation of lynx within the SNF into the future. Management of lynx and its habitat on SNF land will remain in place until the forest amends or revises its LRMP. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended Forest Plans (LRMPs). It is unclear if the SNF will continue to implement lynx direction in the absence of the DPS listing. Once if the DPS is de-listed, the species would be placed on the Forest's Regional Forester Sensitive Species list for a minimum of 5 years, which gives it a higher priority than other species for monitoring and management during that time. The SNF consults with the FWS to consider the effects of any projects to lynx and its critical habitat and is anticipated to do so as long as the species is listed under the ESA.

The Chippewa and the Chequamegon-Nicolet national forests occur outside the Northeastern Minnesota geographic unit and the area considered to be core lynx habitat (i.e., where lynx are persistent and are reproducing) in the Great Lakes Region. However, because lynx occasionally occur on these forests, the Forest Plans for both also include direction based on the LCAS and Canada Lynx Conservation Agreement (CA) between the Forest Service and the Service (Ruediger et al. 2000, entire; USFS and USFWS 2000, entire), for all forest activities that occur within LAUs (USFS 2004b, entire; USFS 2004c, entire). These two forests consult with the FWS to consider the effects of any projects to lynx and are anticipated to do so as long as the species is listed under the ESA. It is unclear if these national forests outside of the lynx core area would continue to implement lynx direction in the absence of the DPS listing.

Additionally, the Minnesota Department of Natural Resources (MN DNR) manages approximately 36 percent of the lynx habitat in this unit, and privately-owned lands make up about 16 percent of the unit. Under the Sustainable Forest Resource Act of 1995 (revised in 2014), the Minnesota Forest Resources Council (MFRC) has developed guidelines for site-level timber harvesting and forest management (MFRC 2013, entire; MFRC 2014, entire). These voluntary guidelines are intended for private and State landowners and include some general recommendations for wildlife but are not specific to lynx (MFRC 2014, pp. 4-5). It is expected that the MFRC guidelines will remain in place into the future and that voluntary actions will continue. Private landowners, however, do not have an official commitment to land management. We cannot say with any certainty what proportion of privately owned land will follow those guidelines into the future, because following the guidelines is voluntary. The MFRC guidelines are less comprehensive and are not specific to lynx, and therefore may not be as beneficial to lynx and lynx habitat as the lynx and hare specific direction followed by the Forests.

The NPS manages Voyageurs National Park, which is also within the Minnesota unit. Voyageurs National Park protects an area of 882 km^2, of which 534 km^2 (62 percent) is covered by forests and other uplands (Moen *et al.* 2012, p. 348), but does not have lynx specific direction in its management plan (NPS 2002, entire). The National Park consults with the FWS

to consider the effects of any projects to lynx (NPS 2002, p. 26) and is anticipated to do so as long as the species is listed under the ESA. Lynx documented on and near Voyageurs National Park are probably transient animals (Moen *et al.* 2012, p. 348).

Approximately 1 percent of the Minnesota unit is managed by the Grand Portage Band of Chippewa, who has been actively working on lynx conservation since 2004. On-reservation timber sales and harvest practices follow an integrated management plan for priority wildlife management, sustainable economic development, and recreational uses. The Band's timber management practices benefit populations of snowshoe hares, the lynx's primary prey (Deschampe 2008, entire) and are expected to continue into the future.

In response to a 2008 court ruling, the MN DNR began to draft a plan to address incidental take of lynx that may result from otherwise legal trapping in Minnesota. This plan is still under development by the MN DNR and will be designed to reduce the likelihood of incidental take from trapping (ILBT 2013, p. 49). If the DPS was not listed, the State would likely still try to reduce incidental take of lynx from trapping; however, it also is possible that State-managed trapping of lynx could resume.

Climate Change - The direct and indirect effects of climate warming are expected to affect lynx in Minnesota (Siren *in* Lynx SSA Team 2016, pp. 15 and Moen *in* Lynx SSA Team 2016, p. 19) and could further restrict their range. Since the DPS was listed in 2000, new information on regional climate changes and potential effects to lynx habitat has been developed (e.g., Danby & Hik 2007; Gonzalez *et al.* 2007; Knowles *et al.* 2006, Notaro *et al.* 2015), and this new information suggests that climate change may be an issue of concern for the future conservation of lynx because lynx distribution and habitat is likely to shift upward in elevation within its currently occupied range as temperatures increase (Gonzalez *et al.* 2007, entire). Greatest stressors of climate change include diminishing snow depth, quality and duration; competition from bobcats and other carnivores; hybridization with bobcat (Schwartz *et al.* 2004, p. 354); loss of spruce-fir to northern hardwoods; and potential future isolation of resident lynx in this unit because of diminishing forest conditions in Ontario.

Gonzalez *et al.* (2007, entire) modeled distribution of boreal forest and future snow conditions under nine different low, medium, and high emission scenarios (IPCC 2007, pp. 44-47) and predicted loss of forest and snow conditions able to support lynx in Minnesota by the end of the century. Notaro *et al.* (2015, pp. 1668-1669) projected changes in lake effect snowfall using downscaled climate models (Abdus Salam International Centre for Theoretical Physics (ICTP) Regional Climate Model version 4 (RegCM4; Elguindi *et al.* 2011 and Giorgi *et al.* 2012 as cited in Notaro *et al.* 2015) for the Great Lakes Basin. Siren (*in* Lynx SSA Team 2016, p. 15) stated that climate models show an increase in lake effect snow in the eastern Great Lakes until 2050, with a decline later in the century, with an overall decline in the amount and duration of pack in the Midwest. Although there are uncertainties about future climate warming, lynx populations in Minnesota are expected to recede northward and decline over the next century (Lynx SSA Team 2016, pp. 37-38).

Lynx require at least four months (120 days) of continuous snow coverage (Gonzalez *et al.* 2007, p. 7). Snow cover days of 1 inch or greater in northern Minnesota (1959 -1979) ranged from 130-160 days, of 6 inches or greater ranged from 85 to 130 days, of 12 inches or greater ranged from 50 to 100 days, of 24 inches or greater ranged from 10 to 30 days (Kuehnast *et al.* 1982, pp. 7-9). In the future, Notaro *et al.* (2015, p. 1675) projected a general reduction in the frequency of heavy lake-effect snowstorms during the twenty-first century, with the exception of projected mid-century increases around Lake Superior when local air temperatures are expected to remain low enough for precipitation to largely fall in the form of snow. The snow season in the Great Lakes basin is likely to become substantially compressed during the twenty-first century with dramatic increases in rainfall (Notaro *et al.* 2015, pp. 1676-1678). The Minnesota unit may be more vulnerable to snowpack loss due to lack of elevational refugia (Siren *in* Lynx SSA Team 2016, p. 15).

Normal annual snowfall from 1981-2010 in northeastern Minnesota ranged from 140 to 241 cm per year (55 to 95 in/yr.) http://www.dnr.state.mn.us/climate/summaries_and_publications/normals_snow_1981_2010.html, accessed 24May2016) and is projected to decline across the Great Lakes Basin (Notaro *et al.* 2015, p. 1675). Snow quality ('fluffiness") is projected to deteriorate in the Great Lakes. Notaro *et al.* (2015, pp. 1671-1674) projected a dramatic decline of Great Lakes ice cover that will become confined to the northern shallow lakeshores during mid-to-late winter by the end of the century. Ultimately, this leads to increased rainfall, not snowfall, as these projected reductions in ice cover and greater dynamically induced wind fetch lead to enhanced lake evaporation and total lake-effect precipitation (Notaro *et al.* 2015, pp. 1674-1678).

Climate change is projected to cause some northward contraction of boreal conifer forest in Minnesota (Gonzalez *et al.* 2007, p. 16, 18) with some potential loss of habitat at the southern portion of lynx habitat in the State (Gonzalez *et al.* p. 2007, p. 19). According to Frelich (*in* Lynx SSA 2016, p. 14), Minnesota could lose the boreal biome completely, possibly within the next 60 to 70 years, with unmitigated climate change. Gonzalez *et al.* (2007, pp. 8, 13) projected that northeastern Minnesota, including the SNF, would continue to have snow conditions suitable for lynx at the end of the century, and may serve as a refugium for lynx in the Lower 48 States. However, Moen (*in* Lynx SSA Team 2016, p. 19) questioned this result, noting that the Gonzalez *et al*. model predicted a much larger distribution of suitable snow conditions than currently exists in Minnesota. Moen presented preliminary snow modeling results that project snow conditions suitable for lynx will shrink significantly by 2055, be limited to extreme northeastern Minnesota by 2070, and may be entirely absent from the state by 2095 (Moen and Catton *in* Lynx SSA Team 2016, p. 19). If a refugium for lynx does persist in this unit in the future, it would likely only consist of the small area in Cook County (the extreme northeastern corner of the unit) with slightly higher elevations (518-701 m [1700-2300 ft) than the majority of the area that is now considered lynx core habitat and would, therefore, support a much smaller number of resident lynx than likely occur in the unit now.

Vegetation Management - Vegetation management similar to that conducted under current Forest Plans will likely continue into the future on Forest Service lands in Minnesota as long as

the DPS is listed. These activities include timber harvest, such as thinning, clear-cutting, shelterwood, partial cut, and uneven-aged cutting; wildlife restoration projects that involve tree cutting, shearing, burning, seeding, and planting; prescribed burning for ecological purposes, hazardous fuel reduction, and site preparation; mechanical site preparation. If the DPS is de-listed, the species would be placed on the Forest's Regional Forester Sensitive Species list for a minimum of five years, which gives it a higher priority than other species for monitoring and management during that time; however, it is unclear what the forest management would entail during or after that period of time.

Vegetation, timber, and minerals management authorized under current Forest Plans in Minnesota have the potential to adversely affect lynx and lynx critical habitat by reducing habitat quality for denning, foraging, and dispersal; disrupting travel, resting, and foraging patterns; disturbing denning females; and reducing habitat quality for lynx prey species, especially snowshoe hares. Depending on the timing, frequency, intensity, extent, amount, or other conditions, impacts may be variable among similar projects. Using the LCAS as a basis, the Forest Plans have incorporated a number of components that would reduce the risk of those impacts into the future. We expect that management direction for lynx addressing vegetation management on National Forest System lands in the future will be incorporated into revised or amended forest plans, using LCAS as a basis. Future Forest Plan revisions will likely maintain broad direction to design and implement vegetation management projects to maintain or restore conditions for lynx foraging and denning habitat and to maintain or improve juxtaposition of required habitat types and connectivity.

Over the long term, the Forest Plan will alter vegetation patterns on the landscape. Suitable hare habitat was predicted to decrease over time with implementation of the Forest Plan, but has actually increased since 2004 (USFWS 2011, p. 51). Management activities that create unsuitable conditions for hare generally include clear-cut and seed tree harvest, and might include management-ignited fire, mechanical site preparation, salvage harvest, and shelterwood and commercially-thinned harvest, depending on unit size and remaining stand composition and structure. Suitable hare habitat is predicted to remain above the range of natural variation, which is essentially a description of conditions that existed prior to European settlement (1600 – 1900 A.D.) of the area (USFS 2004a, p. 105). Further, unsuitable habitat for lynx would vary only slightly with continued implementation of the Forest Plan and would remain distinctly below the maximum of 15 percent unsuitable in a decade prescribed in the LCAS and incorporated into the Forest Plan. Current (2010) unsuitable habitat levels are below what was predicted in the 2004 (USFWS 2011, pp. 51-52). Because suitable habitat on National Forest lands alone is such a high percentage within LAUs and the SNF is the majority landowner within most LAUs, we expect that in the future, the Forest would not approach the LCAS maximum of 30 percent of lynx habitat on all ownerships in an unsuitable condition within an LAU at any time, which would be ensured by corresponding guidance in the Forest Plan.

Wildland Fire Management - Unlike the Maine unit, the susceptibility of the Minnesota unit to fire may be reduced by periodic spruce budworm outbreaks. Measurable defoliation from spruce budworms has occurred in Northeastern Minnesota continuously since 1954 (MN DNR

http://www.dnr.state.mn.us/fid/july2014/articles.html) and is expected to continue into the future. Modeling to evaluate the relative strength of interactions between spruce budworm outbreaks and fire disturbances in the BWCA showed that budworm disturbance can partially mitigate long-term future fire risk by periodically reducing live ladder fuel within the forest types of the BWCA but will do little to reverse the compositional trends caused in part by reduced fire rotations there (Sturtevant *et al.* 2012, pp. 1286-1292).

The SNF manages for wildfires through preventative measures such as fuels reductions, but does not manage for wildfires in the BWCAW. Natural successional changes and those associated with natural phenomena, such as wildfire or windstorms, are and are expected to continue to be the dominant force in ecosystems on the BWCAW.

Habitat Fragmentation - Ravenscroft *et al.* (2010, p. 329) considers northeastern Minnesota forest landscape as largely un-fragmented. The BWCAW remains intact and contiguous with Canada. Within the SNF, natural disturbances and vegetation management activities make up most of the annual human-caused fragmentation in actively managed portions of the Forest. These areas typically re-vegetate within three to five years, depending on the forest type and number and type of activities (USFS 2011, p. 119). The SNF's Forest Plan (USFS 2004a, Appendix E) provides direction on limiting lynx habitat fragmentation and the Forest actively consolidates habitat through land acquisitions and exchanges. The Forest direction limiting habitat fragmentation is expected to continue as long as the DPS is listed.

Fragmentation, Development, and Human Access - Throughout the SNF and northern Minnesota, human activities have reduced connectivity between patches of suitable lynx habitat. Development for residential and commercial uses, as well as roads, railroads, and utility corridors have all interrupted linkage corridors. Still, much of the land within the Forest remains undeveloped and lynx habitat remains relatively intact and well connected. This is particularly true on the SNF, which has a "high standard" (OML 3, 4 and 5) road density of roughly 0.45 mi/mi^2 outside the BWCAW.

Human access to lynx areas occurs by foot and motorized vehicle, including RMVs and off-road vehicles, and generally occurs on trails, low standard roads, and temporary roads developed for management operations, particularly timber harvests, and more recently, minerals exploration. While open, these roads provide access to lynx habitat. As northern Minnesota has become more developed and the human population has increased, the SNF has sustained increased visitation in recent years (USDA 2011) which increases the opportunity for human-lynx encounters, especially by trappers. Lynx are likely to continue to be incidentally trapped at the current rate as a result of continued access via low standard roads and trails on the Forest. Any corridor open to RMVs provides the potential for Forest visitors to incidentally trap, shoot, or collide with lynx. Temporary road construction for minerals exploration projects may have significant contributions to temporary road densities and increase human access during the time the roads are being used. Temporary roads in mineral exploration projects may stay open for more years (1-15 years) than those predicted by the Forest Plan EIS for resource management (1-5 years). If these sites are left accessible to the public, then human-lynx conflicts may

increase. Furthermore, intersections of new roads, closed temporary roads and/or roads open to the public are likely to become parking areas for cars, which would indirectly increase public access. Further, these corridors increase potential competition through increased snow compaction. Effective road closures, however, may reduce the potential effects to lynx and their habitat.

Energy and Mineral Development - Mining (e.g., iron ore and taconite mining) is occurring at several locations in or near the lynx core habitat area in northeastern Minnesota (MN DNR 2016, p. 1). Large-scale mining operations on non-Forest land could result in irreversible or irretrievable loss of lynx and hare habitat. Minerals exploration has increased and is occurring at many locations in northeastern Minnesota (http://www.dnr.state.mn.us/lands_minerals/exploration.html#E, accessed Nov. 28, 2016), which may lead to more large-scale mining projects. Vegetation clearing for minerals exploration projects may have temporary impacts to lynx and hare habitat at drill pad sites, although impacts from pad sites are expected to be minimal and temporarybecause the foot print of individual drill pads is typically small and the cleared land is expected to re-vegetate. Drill pad site preparation includes vegetation clearing on small patches of land (average of approximately 1.6 acres). This cleared land may provide snowshoe hare habitat after it has time to revegetate. Mineral exploration activities use existing Forest roads but also may require construction of new roads and may potentially add a significant number of road miles. Land exchanges associated with proposed mining sites could result in a loss of lynx and hare habitat under Forest management, but may also result in consolidation or gain of habitat with newly acquired lands (*e.g*, the Forest may able to consolidate lands that they can then manage for lynx). Stone quarry extraction operations are also scattered throughout the unit (MN DNR 2016, p. 1) and may impact lynx and hare habitats.

Conclusion

After reviewing the scientific literature concerning climate change projections (diminishing snow conditions, loss of boreal forest, lack of elevational refugia, increased competition, potential disease, and insect outbreaks), some members of the Core Team were slightly more pessimistic about the future of lynx in Minnesota than the lynx expert panel. The Core Team concluded, with slightly more certainty than the expert panel, that the lynx may be extirpated at the end of the century. The experts predicted the probability of persistence to decline to approximately 35 percent by 2100 while the Core Team thought the probability of persistence would be lower at that time. The threat for which the lynx was listed, lack of specific conservation direction, associated regulations, and lynx forest management planning has not been addressed on private lands in Minnesota, except through voluntary guidance. There is some uncertainty about the future of forest management and future development on private forest lands in Minnesota and in adjacent lands in Ontario, although there are some basic voluntary management guidelines for private lands in Minnesota. Further, if the DPS is de-listed, there is uncertainty whether the lynx direction on Forest lands would continue into the future. It is projected that habitat will diminish and recede northward over the mid- to longer-term because of continued climate warming. Furthermore, hybridization and competition with

bobcat may increase with diminishing snow conditions because of continued climate warming and there are uncertainties how insect outbreaks or disease may affect the species or its habitat.

The Core Team believes the Minnesota lynx populations would be expected to decline more rapidly in a future scenario without Federal listing. The lynx is state listed, however, and Minnesota's Endangered Species Statute and the associated Rules impose a variety of restrictions, a permit program, and several exemptions pertaining to species designated as endangered or threatened. Under the state statute, a person may not take, import, transport, or sell any portion of an endangered or threatened species. However, these acts may be allowed by permit issued by the DNR. There is a closed season on lynx, and it is expected that intentional take would continue to be prohibited until the population reached sustainable levels defined by the state. In Minnesota, the large proportion of lynx core area owned by the Forest Service provides a nexus for USFWS review of Forest projects under section 7 of the Endangered Species Act (i.e., there is rarely federal funding spent on forestry and no federal permits required for forest management on private lands), which would be lost post de-listing. Because of their Federal listing, Canada lynx are recognized as a priority species for planning by federal, tribal, state, and private forest landowners. Voluntary guidelines that consider the Federal listing status may guide private landowners to at least consider measures to help conserve listed species in the future. Without Federal listing driving voluntary conservation guidelines, however, there would be little or no motivation for private forest landowners to intentionally engage in forest management to benefit lynx. With current Federal listing, there is a nexus for the USFWS to review other projects in northeastern Minnesota (e.g., Army Corps of Engineers permits for wetland impacts); for new highways, transmission lines, large-scale energy development, mining, and residential and commercial development. Without Federal-listing, these projects would not consider impacts to lynx critical habitat. The Core Team concludes that a future scenario without Federal listing would result in increased habitat loss and fragmentation and would result in reduced justification for habitat protection initiatives in northeastern Minnesota.

Lynx would be at greater risk without Endangered Species Act section 9 prohibitions against take. In a future scenario without Federal listing, Minnesota's incidental take planning effort for trapping may be further delayed or halted and may result in the diminishment of protective measures to minimize injury, take, and mortality of lynx. As it is, approximately 16 lynx have been reported to be incidentally trapped in Minnesota since listing, resulting in at least 6 mortalities. It is unlikely that lynx would become a legally trapped furbearer in Minnesota (although a legal wolf hunt was reinstated post-delisting of that species in Minnesota, so it may also be suggested for lynx). Seven lynx have been illegally shot and reported or otherwise discovered since listing. Illegal shooting and non-reporting would likely increase without federal protection. High-profile law Federal enforcement cases may have helped to reduce illegal shooting of lynx. With a diminished snow regime, populations of bobcats would be expected to increase and expand north and eastward into areas currently occupied by lynx. Incidental take of lynx from bobcat trapping and hunting activities would likely increase without Federal listing. Similarly, fisher, fox, and coyote populations may increase in a diminished snow regime in

northern Minnesota and trapping would be expected to occur there that may lead to greater incidental take of lynx. Without federal listing, shooting lynx may increase. We believe that despite a closed hunting and trapping season, incidental take would continue and possibly increase and could become a significant threat to a population of lynx that will likely be significantly diminished by mid- to late-century.

After considering the best available scientific information, including the opinions of lynx experts summarized above, the Core Team was more pessimistic than the experts about the probability of persistence of Canada lynx in the Minnesota unit. All threats –climate change, habitat loss and fragmentation, mining and development – are increasing in frequency, intensity, and extent. Lynx habitat in the next few decades will likely shift north to areas that will be more influenced by climate change and northward range expansion by bobcats. Thus, we conclude that the carrying capacity to support lynx is diminishing, and the lynx population will likely decline as the quantity and quality of boreal forest habitat declines. Although there are voluntary measures to consider listed species on private land forest management, there are no commitments by private forest landowners to management plans to ameliorate this stressor. After reviewing the best available scientific information, we believe that climate change is a significant threat to lynx in the Minnesota unit; slightly more so than expressed by most of the experts. Deep, fluffy snow is critical to the existence of hare and lynx, and snow depth and duration are currently at or below the thresholds believed necessary to support lynx. Unlike most other units, as snow condition decline there is little potential for elevational refugia for lynx in Minnesota except, perhaps, a small area of slightly higher elevation in extreme northeastern Minnesota in Cook County. The boreal forest in this unit is already being replaced by northern hardwoods because of climate change. Frequent forest cutting and disturbance, including a potential insect outbreak, could accelerate conversion to northern hardwoods. We acknowledge that the rate of boreal decline is uncertain, but note that some of the science reviewed indicates the spruce-fir forest type could nearly disappear from Minnesota by late-century under both low and high emissions scenarios. Climate change models portend declining snow conditions from low- to high-emissions. Because increases in temperature are thus far tracking high emissions scenarios, we are less optimistic for snow conditions that favor lynx by mid- to late-century. In the past decade, interest in development has increased in lynx critical habitat, especially proposals for large-scale mining developments. We conclude that these threats, individually and cumulatively, indicate diminished populations of lynx and their habitat. If these threats are not abated, we believe that resident lynx in this unit will have a slightly greater likelihood of extirpation by the end of the century than was predicted by lynx experts.

5.2.3 Unit 3 - Northwestern Montana/Northeastern Idaho

Expert Projections of Lynx Persistence

Because of its connectivity to lynx populations and habitats in Canada, its large geographic extent, and the relatively large number and broad distribution of resident lynx it is thought to support, future extirpation of lynx from this unit from either reduced genetic health or a catastrophic event is unlikely (Lynx SSA Team 2016, pp. 25-34). When considering the

probability that this unit would continue to support resident lynx in the future, experts noted that despite projected losses of favorable forest and snow conditions, climate models project that some boreal forest will persist in this unit and that it will maintain some areas of suitable snow into the future. Experts also noted that lynx in this unit primarily occupy public lands, which are actively managed for lynx into the future. Experts also considered recent and projected future increases in wildfire frequency, size and intensity.

As for most other geographic units, all experts indicated an initially high and subsequently decreasing probability of the persistence of resident lynx in this unit, with increasing uncertainty over time, but a higher probability of persistence at all time frames than other units. All experts predicted near-term (year 2025) persistence probability >= 95%, mid-century persistence at 70% to 100% (median = 90%), and end-of-century persistence probabilities >= 50% (median = 78%) (Figure 10, below).

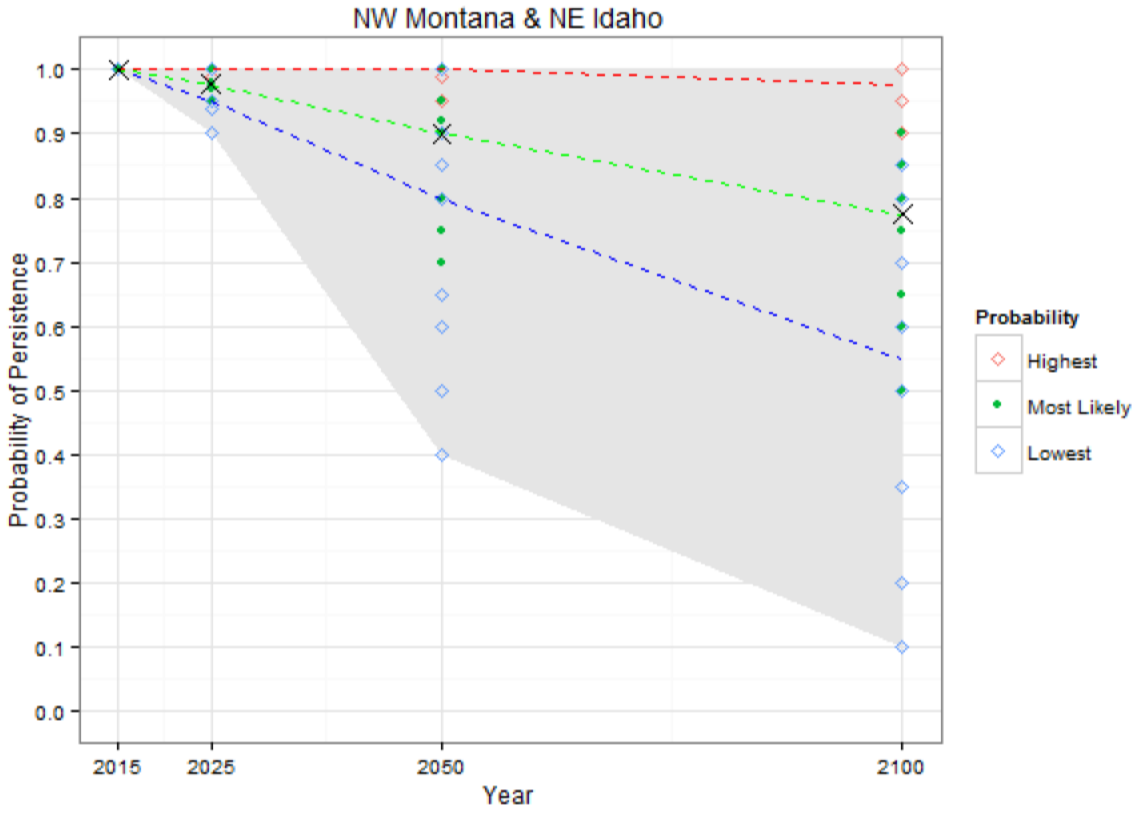


Figure 10. Lynx expert estimates of the probability that the Northwestern Montana/Northeastern Idaho Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Overall, experts assigned a higher probability of persistence in this unit compared to the other geographic units. Most lynx habitats in this unit occur on Federal lands that are managed for lynx conservation, but one expert noted that little has been done to document whether lynx are responding to this management. The recent sale of large tracts of private commercial

timberlands in the central part of this unit to The Nature Conservancy has increased protection for lynx via conservation easements managed for lynx. Habitats in some areas should improve in the near future as previously cut or burned areas mature into dense stands. Unlike the Maine and Minnesota geographic units (but similar to most other western units), high elevations in this unit could buffer the effects of climate change by providing for the upslope migration of lynx habitats and snow conditions that climate models predict. However, this would result in even patchier and more isolated islands of habitat in high elevation areas that would be more prone to extirpation from catastrophic or stochastic events. Competition from coyotes and bobcats seem to be less of a concern for this unit.

This unit has unimpeded connectivity with Canada, but some experts questioned whether this geographic unit depends on intermittent immigration of lynx from Canada, and whether the historical lynx population cycles in Canada believed to have fueled such immigration are still occurring or will into the future. There doesn't appear to be much demographic input from recent cycles. There is evidence of lynx from this unit moving north into Canada, but little evidence of demographic interactions among the three subpopulations (Purcell Mountains, Seeley Lake, and Garnet Mountains) in this unit. Experts noted that the Garnets Mountains subpopulation at the southern end of this unit may have recently become extirpated.

Discussion among experts indicated that fire was more of a concern for this area. Increased fire extent and severity or other catastrophic events and small subpopulation effects in separated mountain ranges could affect lynx persistence in the future in some parts of this unit. Fire exclusion in this area for the last 100 years likely resulted in the accumulation of fuels; however, this unit may have a reduced probability of a catastrophic fire over time because of recent changes in management and recent fires that may have reduced fuels. Out to the year 2050 and beyond, some experts felt there may be more pressure on lynx populations in this unit from continued increases in fire extent and severity. Other experts expressed a different opinion of the overall effect of fire in this unit, indicating that it may actually improve habitat over time, and that whether fires improve or degrade habitat depends on the frequency, intensity, size and spatial extent of future fires.

Experts discussed the possibility for increased precipitation and warmer temperatures in this unit because of climate change, and how this might affect lynx habitats. Boreal/subalpine forest may move up in elevation as described above; however, experts expected a shift in forest composition and diminished lynx habitat quality in future with climate change. It is unknown how much the distribution of dry ponderosa pine (non-habitat for lynx) will increase with climate change, but it is likely to happen at some level. One expert cautioned that some climate modelers estimated that vegetation will lag about 50 years behind the projected changes in temperature and precipitation. Snow levels in lower elevation areas are already decreasing in some areas, which could lead to smaller areas for lynx to use in winter in the future.

<u>Service Evaluation of Factors Potentially Influencing Future Conditions</u>

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Regulatory Mechanisms - Federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Because most (84 percent) of this geographic unit consists of Federal lands, the regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations in this unit. When Forest Service, Park Service, and BLM management plans are revised or amended, they require opportunities for public participation in accordance with several statutes (e.g., the National Environmental Policy Act [NEPA], National Forest Management Act [NFMA], National Parks and Recreation Act, Federal Land Policy and Management Act [FLPMA]) (USFWS 2014 pp. 26-34, also see 3.1, above). If plan amendments or revisions may affect listed species, management agencies must consult with the Service in accordance with section 7 of the ESA. If in the future the lynx DPS is determined by the Service to be recovered and the protections of the ESA no longer necessary (i.e., if the DPS is removed from the *Federal Lists of Endangered and Threatened Wildlife and Plants*), the ESA requires the Service, in cooperation with the States, to monitor the DPS for a minimum of five years to assess its ability to sustain itself without the ESA's protective measures. If, within the designated monitoring period, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future Federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future Federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historical disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that Federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (BLM 2004a, pp. 2-3; USFS 2007, Attachment 1, p. 2). Although specific standards and guidelines may change as new scientific information and management techniques become available, we

anticipate continued Federal management designed to conserve or restore the capacity of the areas that historically or recently supported resident lynx populations, including the Northwestern Montana/Northeastern Idaho Geographic Unit, to continue to do so in the future.

On non-Federal lands (about 16 percent of this unit), as described above (sections 3.1.1 and 4.2.3, Habitat Status), recent acquisitions and conservation easements on some of the private lands in this unit will also reduce the likelihood of future adverse impacts to important lynx habitats. Similarly, the MTDNRC HCP includes a 50-year commitment to manage most (64 percent) State lands in this unit to conserve lynx foraging, denning, and connectivity habitats. Additionally, the Confederated Salish and Kootenai Tribe's objective to manage wildlife and habitats on the Flathead Reservation for future generations (section 3.1.2, Tribal Management, above) suggests continued management to conserve lynx habitats on Tribal lands.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support conservation and restoration of lynx habitats in this unit and improve the likelihood that it will continue to support resident lynx into the future.

If the DPS was not listed, it is possible that State-managed trapping could resume in this and perhaps other geographic units. We expect that would only occur if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.3, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), although some parts of this unit are projected to retain adequate

snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 41). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely compromising this unit's continued ability to support resident lynx populations.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, and to increased frequency and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on future lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of these landscapes to continue supporting resident lynx may be compromised, and lynx populations may be unable to persist until favorable vegetation conditions return. This is especially true where habitats and populations are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much if not all of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced (as is suspected) by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will reduce this geographic unit's ability to continue to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx populations in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historical and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will reduce future habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all Federal and most non-Federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use

of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.3, above, past wildfire management, including fire suppression, does not appear to have altered the historical fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current Federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.3, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although this increased wildfire activity does not appear to have diminished this unit's current ability to support resident lynx, it could do so in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand-initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support a resident lynx population until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity resulting from continued climate warming and drying, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.3, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation resulting from timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

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Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – As described above and in section 4.2.3, maintaining connectivity between this geographic unit and lynx populations in Canada is thought to be important, although it is uncertain if or to what degree immigration of lynx from Canada is essential to the persistence of lynx in this unit. A number of climate-mediated factors have been suggested as contributing to changes in the periodicity and amplitude of northern lynx and hare population cycles (see section 3.2, above), which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in this unit rely on immigration from Canada which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and a reduced probability of persistence among resident populations would be expected.

Although the extent to which this factor may influence lynx populations in this unit is unknown, the population growth rate estimated for the Seeley Lake area ($\lambda = 0.92$, declining trend 1999-2007; Squires *in* Lynx SSA Team 2016, p. 20) may reflect a gradual decline of a resident lynx population that needs but is not receiving adequate immigration. If this growth rate was applied continuously to a hypothetical resident population of 250 lynx (the midpoint of the range in the number of resident lynx this geographic may support based on expert opinion [Lynx SSA Team 2016, p. 41]), the population would decline to 100 lynx after 11 years, about 50 lynx after 20 years, and roughly 20 individuals after 30 years. Vulnerability to demographic, environmental, and genetic stochasticity would increase as lynx numbers decreased, resulting eventually in an increased likelihood of functional extirpation of lynx from this unit (i.e., a lower probability that the unit would continue to support a persistent resident lynx population). However, as noted above, the lynx population in the Purcell Mountains in the northwestern part of this unit was estimated to be increasing ($\lambda = 1.16$, 2003-2007; Squires *in* Lynx SSA Team 2016, p. 20) over the last four years of the period for which the Seeley Lake population was estimated to be declining. In the absence of information on historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

Conclusion

After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is likely

the most secure in the DPS. We conclude that it is very likely to continue to support resident lynx in the short term (through 2025) and through mid-century, although the number of lynx, the amount and distribution of high-quality habitat, and landscape-level hare densities are all likely to decline by mid-century as a result of continued climate warming and associated impacts. We also agree that this unit is more likely than not to support some resident lynx at the end of this century, although at that time we expect lynx numbers and distribution would be substantially reduced from the current condition and would, therefore, be more vulnerable to demographic, environmental, and genetic stochasticity and to catastrophic events, resulting in diminished resiliency. We acknowledge that under a *status quo* or increasing greenhouse gas emissions scenario the rate of climate-mediated loss, fragmentation, and isolation of habitat could, perhaps in concert with other factors (e.g., decrease in or complete loss of immigration from Canada), result in the functional extirpation of resident lynx from this unit before the end of the century.

5.2.4 Unit 4 - North-central Washington

Expert Projections of Lynx Persistence

Compared to the previous units, most expert graphs showed a lower probability of persistence for this unit over the short term, and then lower probability of persistence along with increasing uncertainty by 2100, reflecting a more pessimistic outcome for this unit compared to previous units (Figure 11). Experts predicted near-term (year 2025) persistence probabilities of 60% to 90% (median = 80%), and mid-century persistence at 30% to 80% (median = 70%). All experts predicted end-of-century persistence probabilities less than 50%, with a median of 38%, by 2100 (Figure 11). However, one expert predicted an increase in persistence probability by mid-century as habitats impacted by recent large-scale fires regenerate into optimal hare-lynx habitat.

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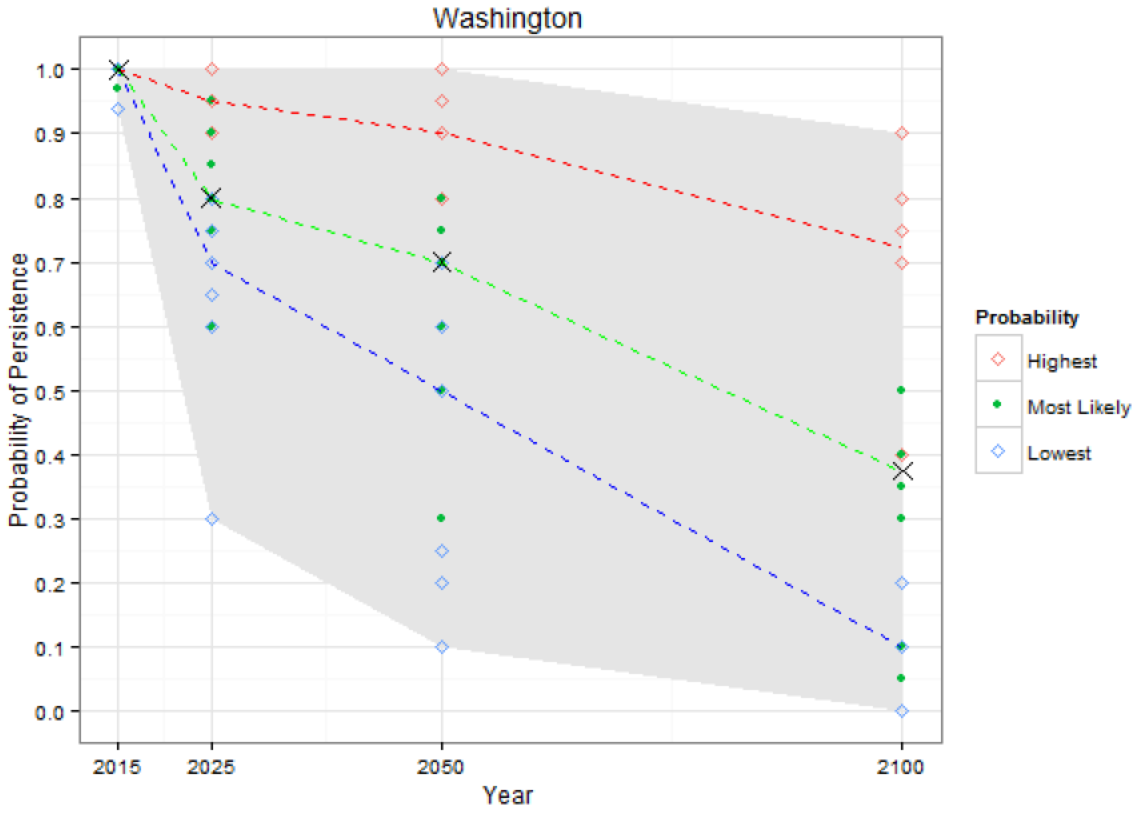


Figure 11. Lynx expert estimates of the probability that the North-central Washington Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

The probability of lynx persistence in this unit could decrease sharply over the next 10-20 years because of extensive recent fires in lynx habitats and the time needed for these areas to regenerate back to good hare/lynx habitat. After that, the probability could rebound (or decline more slowly) over the longer term as these large areas return to prime habitat providing high hare densities. The current small population is likely at greater risk of extirpation because of stochastic events, particularly if large fires in lynx habitat continue to occur in the near future as they have in the recent past. A small population also could be more susceptible to disease, though none has been documented among lynx in this unit. Experts discussed the extent to which small lynx populations could be reduced before they would become highly susceptible to stochastic demographic effects. It was suggested that 15-20 breeding individuals might be the minimum needed to avoid such susceptibility. Unimpeded connectivity between Canada and the Okanogan area of this unit could allow lynx to repopulate currently-unsuitable areas after the habitat recovers. Lynx in this unit are likely the southern portion of a larger population in Canada, not really a separate, isolated small population. Factors that influenced expert persistence probabilities for this unit included fire, habitat loss, and the future loss of favorable snow conditions predicted by climate change models.

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - As stated previously, it appears that, currently, adequate protective regulatory mechanisms are in place in this geographic unit. Looking to the future, relative to the regulatory risks to lynx, we do not anticipate the existing regulatory protections for lynx to diminish. We anticipate that either the CA will remain in place (and/or be extended), or the OWNF and CNF will revise or amend their respective LRMPS incorporating direction for lynx management similar to what has occurred with other 18 National Forests in Idaho, Montana, Utah, and Wyoming. These 18 National Forests amended their respective LRMPs with lynx management direction known as the Northern Rockies Lynx Amendment (NRLA) in 2007. The NRLA incorporated management recommendations from the LCAS, with modifications based on the advent of new information pertaining to the management of lynx. Currently, both the OWNF and CNF are in the process of amending or revising their LRMPs. We expect that management direction for lynx addressing vegetation management, wildland fire management, and habitat fragmentation on national forest system lands will be incorporated into the revised or amended LRMP. Also, as discussed previously, the WADNR has developed and is implementing its 2006 Lynx Plan. The WADNR commits to implementing the 2006 Lynx Plan until lynx are delisted or until 2076, whichever is shorter (WADNR 2006, p. 6). Thus, it appears the regulatory future of lynx management, and thus, lynx habitat management, is largely secure on both Federal and State managed lands within Washington State.

Further, should lynx be delisted, the management for and status of lynx in this geographic unit should be largely secure (insofar as we can affect their status [i.e., notwithstanding effects of climate change)] as greater than 90 percent of lynx habitat in this unit consists of Federal ownership on the OWNF and CNF. We expect that both the OWNF and CNF will be required to manage for lynx and their habitat into the future because both forests will have incorporated lynx management direction into their respective LRMPs. We acknowledge that LRMPs can be amended or revised. However, LRMPS are typically in place for 15 years or longer, and the Service, other Federal and State agencies, and the public would have opportunities to comment on any proposed amendments or revisions to the OWNF and/or CNF LRMPs through the National Environmental Policy Act process. Therefore, we expect that both the OWNF and CNF will continue managing for lynx and their habitat into the future regardless of their listing status.

Climate Warming - The one risk factor identified by the LCAS which the Forest Service, or the WADNR for that matter, has little ability to control or influence is climate change. Climate change was identified by the panel of lynx experts convened during development of the Canada Lynx Expert Elicitation Workshop Report to potentially represent the greatest threat to the long-term persistence of lynx (Lynx SSA Team 2016, p. 56). Our review of the published literature on this subject leads the Core Team to conclude that climate change does indeed pose the greatest risk to the long-term persistence of lynx, including within this geographic unit.

Potentially further exacerbating the recent losses of lynx habitat from fires is climate change. Climate change may affect fire return intervals and severity as well as the quality and depth of snow within lynx habitat. Westerling *et al.* (2006, pp. 942-943) compiled information on large

wildfires in the western U.S. from 1970-2004 and found that large wildfire activity has increased significantly from the mid-1980s with large-wildfire frequency, longer wildfire duration, and longer wildfire seasons. The greatest increases occurred in high elevation forest types including lodgepole pine and spruce fir in the northern Rockies (i.e., lynx habitat). They also found that fire exclusion had little impact on natural fire regimes. Rather, climate appeared to be the primary driver of increasing wildfire risk. As stated previously, Koehler's (1990, p. 847) estimated adult lynx density of 2.3 lynx/100 km^2 was obtained in an area supporting high quality lynx habitat in the Meadows area of north central Washington (at least relative to other lynx habitat in Washington). Much of the lynx habitat in the Meadows was impacted by the recent large, stand replacing fires in the Cascades, resulting in further fragmentation of lynx habitat in the northern Cascades. Thus, the lynx densities Koehler observed in his study area may not be currently supported, because as habitat becomes more fragmented and isolated (i.e., marginal), the carrying capacity for a particular species declines.

Additionally, relative to the persistence of Washington's lynx population, during the lynx expert elicitation workshop several of the lynx experts expressed concern that should more wildfires occur within the next 10 years and result in losses of lynx habitat similar to the impacts caused by the recent wildfires, such wildfires could result in the functional extirpation of lynx in Washington. The experts expressed heightened concern of functional extirpation of lynx in this geographic unit from wildfires because of its small size and current lynx population (Lynx Workshop Report 2016, p. 27). However, the experts felt the potential extirpation of lynx, should it occur from a large catastrophic wildfire(s) (or other mechanisms such as insect outbreaks), may be ameliorated to some extent because of Washington's juxtaposition and connectivity to Canadian lynx populations. The experts felt that lynx immigration from Canada may rapidly recolonize Washington as the habitat recovers from fires or other impacts (Lynx Workshop Report 2016, p. 43). Climate change, in addition to potentially affecting fire return intervals, fire severity (intensity, size), and insect outbreaks, is likely to affect the amount of precipitation falling as snow at elevations typically supporting lynx habitat in this geographic unit.

Lynx survive in areas with cold, snowy winters providing deep, fluffy snow (78 FR 59443) that gives lynx competitive advantages over other competitors and predators of lynx, as well as providing the conditions supporting the lynx's main prey, the snowshoe hare, which can comprise as much as 97 percent of their winter diet (Koehler and Aubry 1994, p. 75). Snowshoe hares are limited to environments with snowy climates (Ruggiero *et al.* 2000b, p. 448).

Climate change may impact the quantity, quality, and temporality of snow in the Cascades. Mote (2003b, pp. 272, 274), who evaluated temperature trends in the Pacific Northwest using data collected by weather stations from 1930 to 1995, determined that the temperature increased in the Pacific Northwest, and more precipitation fell in the spring and summer months, especially at elevations below 1,800 m (5,900 ft). Additionally, Mote (2003a, pp. 2-3) determined that an increasing temperature and precipitation trend from 1950 to 2000 is correlated with a 40 percent decrease in the snow water equivalent in the Cascades. Mote *et al.* (2005, p.45) determined that the Cascades are very sensitive to temperature changes, with large increases in temperature potentially resulting in significant declines in snowpack. Corroborating Mote's

speculation, Stoelinga *et al.* (2010, p. 2474) determined that the Cascade snowpack has declined by up to 40 percent in the latter half of the twentieth century, which resulted from increased temperatures. Furthermore, predicted continued increasing temperature changes of 2° C to 5° C over the next century are expected to cause further and accelerated losses in snowpack in the Cascades (Mote *et al.* 2005, p. 48). Continued declines of snowpack in the Cascades through 2025 are predicted to range from 9 percent (Stoelinga *et al.* 2010, p. 2486) to 29 percent (Elsner *et al.* 2010 *cited in* Stoelinga *et al.* 2010, p. 2486), which may also affect lynx densities supported in the Cascades. Finally, some of the best lynx habitat in this geographic unit occurs on plateaus that may be more vulnerable to impacts of climate change because of the absence of higher elevation areas to which habitats and lynx could migrate in response to climate warming (Lynx Workshop Report 2016, p. 42). Thus, in addition to the recent losses of lynx habitat to large wildfires, coupled with increasing wildfire risk, the potential for the Cascades to support a viable lynx population may be further reduced because of projected climate-mediated decreases in snow quantity and quality.

Similar to the potential effects of wildfires on the persistence of the lynx population in this geographic unit, the lynx experts identified climate change relating to loss of favorable snow conditions as a significant factor potentially affecting the long-term persistence of this population (Lynx Workshop Report 2016, pp. 43-44). Taking all factors into consideration (i.e., catastrophic wildfire, insect outbreaks, loss of snow), the experts felt the probability of this population persisting to the year 2050 most likely ranged between approximately 60 percent to 80 percent, declining by the year 2100 to approximately 30 percent to 50 percent (Lynx SSA Team 2016, p. 43). The Core Team generally agrees with this prognosis.

Conclusion

After considering the best available scientific information and the opinions of lynx experts summarized above, the Core Team is generally in agreement with the experts regarding the probability of long-term persistence of Canada lynx in this geographic unit. As described above, the potential effects of climate change upon the quantity and quality of snow, as well as the northward and upslope movement of spruce-fir and subalpine fir forests are likely to result in further fragmentation and reduction of lynx habitat within this geographic unit by the end of the century. More fragmented and smaller habitat patches are likely to support fewer lynx as well within this geographic unit. A smaller and more isolated lynx population within this unit is likely to increase the population's vulnerability to stochastic environmental and demographic events. Recent wildfires have reduced lynx habitat within this geographic unit to approximately 1,600 km^2 (618 mi^2). Additional losses of lynx habitat resulting from wildfires (increasing risk of wildfires is related to climate change) may pose the greatest near-term threat to the persistence of this population. The Service's Recovery Outline (USFWS 2005, p. 5) suggests that landscapes of at least 1,250 km^2 (483 mi^2) are the minimum landscape size thought necessary to support a minimum population of at least 25 lynx. However, also as noted above, the lynx population in this geographic unit is connected to lynx populations in Canada. Currently, the connectivity of this population between the United States and Canada appears intact. Given that lynx are highly mobile and able to traverse large areas of non-lynx habitat, we do not

anticipate that climate change, in and of itself, will significantly affect the connectivity of the lynx population within this geographic unit to the lynx population in Canada. In fact, it is likely that the lynx population in this geographic unit in the Cascades is an extension of the lynx population in Canada. This connectivity may contribute to maintaining a persistent, albeit smaller, lynx breeding population in this geographic unit.

5.2.5 Unit 5 - Greater Yellowstone Area

Expert Projections of Lynx Persistence

The expert graphs for this unit were widely variable and had different outcomes and high uncertainty at all time frames. Experts predicted near-term (year 2025) persistence probabilities of 10% to 70% (median = 52%), and mid-century persistence at 15% to 60% (median = 35%). All experts predicted end-of-century persistence probabilities less than 50% for this unit, with a median of 15%, by 2100 (Figure 12). This was the only unit for which most experts believed the present probability of persistence is low (i.e., that it is uncertain whether this area currently supports a resident lynx population). Some experts increased probability of persistence into mid-century as the 1980s-era fires regenerate into hare/lynx habitat, and with the possibility of continued immigration of lynx from Colorado. Other experts project a 10% to 20% probability of persistence by 2100. One reason given for wide variability in responses is because of the uncertainty whether a population currently exists. There were wide confidence intervals around the probabilities for all time periods for this area.

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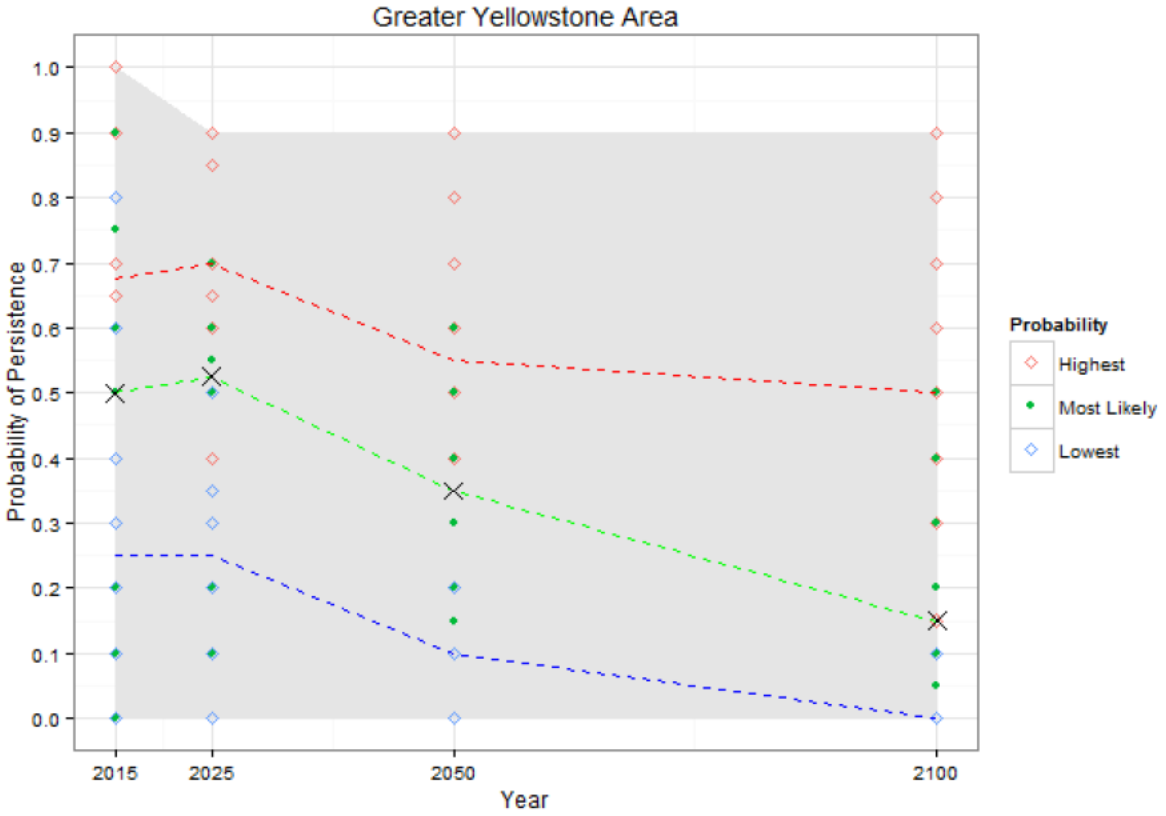


Figure 12. Lynx expert estimates of the probability that the Greater Yellowstone Area Geographic Unit will continue to support resident lynx in the future (at years 2025, 2050, and 2100).

Current and future factors expressed by experts as influencing probability of persistence for this unit included small population size, forest disease and insect pests, and fire. Some experts doubt that the GYA unit currently supports a resident breeding population of lynx. Experts indicated that climate models predict that some parts of the GYA unit could provide refuge from climate change impacts because of their high elevations and potential to maintain winter snow levels into the future. Summer conditions in this unit, however, could be drier in the future, resulting in increased fire frequency, extent and intensity, and additional temporary habitat loss. However, regeneration of these areas and the extensive areas that have burned in the recent past may provide good habitat over the next several decades. Lynx immigrating to this unit from Colorado could occupy such improved habitats in the near future. Colorado lynx have made exploratory movements into the GYA in summer months, and analysis of available data could improve our understanding of Colorado lynx movement into and use of the GYA. It is possible that lynx from Colorado are maintaining or could maintain lynx in GYA.

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - As noted above in section 5.2.3, Federal, State, and Tribal regulations and land management direction could change in the future, but such changes and their potential impacts on lynx populations and habitats are difficult to predict. Federal lands account for over 97 percent of this geographic unit; therefore, regulations and guidance that govern management of those lands have the greatest potential to influence future lynx habitats and populations. Also as described above, revisions or amendments to Federal management plans require opportunities for public participation in accordance with NEPA, NFMA, National Parks and Recreation Act, and FLPMA (USFWS 2014 pp. 26-34; also see 3.1, above) and consultation with the Service in accordance with section 7 of the ESA. If the DPS were to be recovered and delisted in the future, the ESA requires a minimum of five years of monitoring to assess its ability to sustain itself without the ESA's protective measures. If, during that time, threats to the DPS change or unforeseen events affect its stability, then the DPS may be relisted or the monitoring period extended. Given these requirements, we expect that future Federal management direction will continue to include regulations and guidance protective of lynx, although specific measures may change as new information becomes available.

We anticipate that future Federal management direction will include continued management of national parks, designated wilderness and roadless areas, and other areas with nondevelopmental land-use allocations to maintain natural ecological processes, which should maintain natural disturbance regimes and landscape-level habitat mosaics to which lynx are adapted (although continued climate warming [see below] may preclude maintenance of historical disturbance and landscape patterns). Regardless of the future listing status of the DPS, these lands will continue to be managed in accordance with the acts described above, as well as the National Park Service Organic Act and the Wilderness Act.

We also expect that Federal management into the future will include continued management of lands with developmental allocations to avoid or minimize potential impacts of vegetation management (timber harvest, thinning, salvage logging, other silvicultural prescriptions), wildland fire management (fire suppression, fuels reduction, prescribed fires), energy exploration and development, recreation, or other management activities with the potential to affect lynx. Current and likely future objectives include (1) managing vegetation to mimic or approximate natural disturbance and succession processes while maintaining habitat components necessary for lynx conservation; (2) providing a mosaic of habitat conditions through time that supports dense horizontal cover, high hare densities, and winter hare habitat in both young regenerating and mature multistoried forest stands; (3) using fire (natural and prescribed) to restore ecological process and maintain or improve lynx habitat, and (4) focusing vegetation management in areas with potential for improving winter hare habitat (USFS 2007, Attachment 1, p. 2; BLM 2008, pp. A18-10 - A18-15; BLM 2010, pp. A-9 - A-12). Although specific standards and guidelines may change as new scientific information and management techniques become available, we anticipate continued Federal management designed to conserve or restore potential lynx habitats in this geographic unit in the future.

Given the commitments and management objectives and practices described above, implementation of current and future regulatory mechanisms will likely continue to support

conservation and restoration of lynx habitats in this unit and improve the likelihood that it will support resident lynx into the future. Because non-Federal lands make up such a small proportion of this geographic unit, we believe it is unlikely that regulatory mechanisms on those lands will influence this unit's future ability to support resident lynx.

If the DPS was not listed, State-managed trapping could resume in this geographic unit. We expect that would occur only if scientific evidence strongly suggested the presence of a harvestable surplus of lynx and that harvest quotas would be carefully managed to ensure that the viability of resident lynx populations would not be diminished or that potential recovery objectives were not otherwise compromised.

Climate Change - The recent evidence of climate change and the numerous mechanisms by which continued warming may affect future conditions for lynx and the potential consequences for the DPS and specific geographic areas are described in detail in section 3.2, above. Also, as noted above in section 4.2.5, evidence of warming and related impacts (increased temperatures, reduced snowpack, earlier snowmelt, and increased drought leading to increased fire) have already been documented in the Northern Rocky Mountains, including this geographic unit. Climate projections suggest these impacts are likely to continue and to result in future northward and upslope contractions in the snow conditions and boreal/ subalpine vegetation communities that support lynx. This is expected to cause loss and increased fragmentation and isolation of lynx and hare habitats and, therefore, declining and more vulnerable lynx populations in the DPS and in this geographic unit (Carroll 2007, entire; Gonzalez *et al.* 2007, entire; ILBT 2013, pp. 69-71; 79 FR 54810-54811; Lawler and Wilsey *in* Lynx SSA Team 2016, pp. 15-16; Siren *in* Lynx SSA Team 2016, p. 15).

Snow conditions in this unit are projected to become less favorable, with an overall decrease in snowpack after mid-century as a result of a shorter snowfall season, fewer days with snowfall, and a lower proportion of winter precipitation in the form of snow (more as rain; Siren *in* Lynx SSA Team 2016, p. 15). In this unit, the probability of suitable snow conditions is modeled to decline from 90-95 percent from 1961-1990 to 50 percent across much of the unit by the end of this century (years 2071-2100), though some parts of this unit are projected to retain adequate snow (Gonzalez *et al.* 2007, pp. 12-14; Lynx SSA Team 2016, pp. 15, 46). There will likely be a lag time between the loss of favorable snow conditions and an eventual shift/ contraction in vegetative communities (Lynx SSA Team 2016, pp. 43, 59; also see 3.2, above), but continued warming is projected to convert much of the boreal forest in this unit to temperate conifer forest by the end of the century (Gonzalez *et al.* 2007, pp. 15-17). The ability of lynx and hare populations to persist during this lag and to adjust to future habitat distributions is uncertain, but habitat quality, quantity, distribution, and connectivity are expected to decline, likely further compromising this unit's ability to support resident lynx populations, which is already questionable.

Climate change has also been linked to increased wildfire size, frequency, and intensity in this geographic unit, including the extensive fires in Yellowstone National Park in 1988, which burned over one-third of the park. Climate warming has also been linked to increased frequency

and extent of forest insect outbreaks in other parts of the DPS. These factors are likely to have temporary impacts on lynx habitat, with regeneration to hare and lynx foraging habitat 20-40 years post-disturbance, depending on local climate, elevation, and topography. However, if extensive areas are affected, the ability of landscapes in the GYA to support resident lynx may be further compromised, and resident lynx may be unable to persist until favorable vegetation conditions return. This is especially true where potential habitats are naturally fragmented and patchily-distributed, and where landscape-level hare densities are already marginal, which appears to be the case for much of this geographic unit.

Climate change has also been implicated in observed declines in the amplitude of northern hare and lynx population cycles (Yan *et al.* 2013, p. 3269). If lynx populations in this geographic unit are influenced by intermittent immigration from the north, and if climate change diminishes the likelihood of future immigration via muted northern lynx population cycles, the future persistence of resident lynx in this unit is uncertain (see also Other Factors, below).

Given the factors described above, recent and projected future climate warming will further reduce this geographic unit's ability to support resident lynx into the future. The timing and magnitude of climate-driven impacts are uncertain; however, all are anticipated to adversely affect, and none are expected to benefit, lynx and habitats in this geographic unit. Climate model uncertainties and resolution limits, combined with our imperfect understanding of historical and current lynx numbers and habitat distributions, preclude quantifying future habitat quality/ distribution or lynx population dynamics in this unit. Nonetheless, it appears likely that continued climate warming will further reduce habitat quality and quantity and, therefore, the likelihood that this geographic unit will support resident lynx in the future.

Vegetation Management - Future vegetation management and, therefore, its implications for future lynx habitats and populations in this unit, are closely linked to the current and future regulatory mechanisms described above. As noted, we expect future vegetation management on all Federal lands in this unit to continue to focus on maintaining and restoring lynx habitats by implementing standards, guidelines, and BMPs based on the best available scientific information. We expect these measures to continue to benefit lynx by limiting detrimental effects of timber harvest, thinning, fuels management, etc., and encouraging the use of these activities to restore, improve, or create high quality hare and lynx foraging habitats where feasible.

Wildland Fire Management - As noted in sections 3.4 and 4.2.5, above, past wildfire management, including fire suppression, does not appear to have altered the historical fire regime in lynx habitats in the western contiguous U.S., including this geographic unit. Also as noted there and in sections 3.1.1 and the Regulatory Mechanisms section of this chapter, current Federal management restricts, with few exceptions, fire management (fuels reductions, prescribed fires, etc.) impacts to lynx habitats, and it promotes the use of such activities and wildfire response to conserve and restore lynx and hare habitats. We expect such conservation-focused fire management to continue and, therefore, to benefit lynx rather than to affect them detrimentally in the future.

However, as also noted in section 4.2.5, increased wildfire frequency, size, and intensity have been documented in this geographic unit, and that pattern is anticipated to continue in the future with continued climate warming. Although the extent to which increased wildfire activity has impacted this unit's current ability to support resident lynx is uncertain, such impacts may become more likely in the future depending on the timing and extent of future fires. As described in section 3.4, increases in fire frequency and size could rapidly convert large areas to the temporarily unsuitable stand- initiation successional stage, thus reducing the amount and altering the distribution of higher-quality habitats and potentially compromising this unit's ability to support resident lynx until burned habitats recover. Because lynx habitats are naturally patchily-distributed and landscape-level hare densities already marginal in many parts of this unit, it is possible that very large wildfires or many over a short time period could tip some parts of this unit from just barely capable of supporting resident lynx to incapable of doing so in the future. Although fire suppression was considered a potential risk factor for lynx in the DPS range, given the trends discussed above and the likely continued increase in future fire activity resulting from continued climate warming and drying, it may be necessary to reconsider whether fire suppression in some lynx habitats could benefit lynx by reducing the potential for extirpation of resident populations, especially in places already apparently only marginally capable of supporting them.

Habitat Loss/Fragmentation - As described above in section 4.2.5, lynx habitats in this unit are naturally fragmented but otherwise appear to be largely intact relative to historical conditions in most of this geographic unit. Although some localized impacts of past timber harvest and related activities have likely occurred, anthropogenic habitat loss or fragmentation does not appear to have broadly diminished this unit's ability to support resident lynx. Current and probable future management for conservation of lynx habitats suggests that broad-scale habitat loss or fragmentation from timber harvest and other development activities are unlikely. The most likely sources of future habitat loss and fragmentation in this unit are the climate-mediated influences discussed above: increased wildfire activity and the projected contraction in vegetation and snow conditions favorable for lynx. Increased frequency, size, and severity of forest insect outbreaks, also driven by climate warming, has been documented in other geographic units and could occur in this unit in the future, too, resulting in temporary habitat loss and increased (though also temporary) fragmentation.

Additional highway construction and other transportation developments are likely in this unit, but the future locations, size, and potential impacts of such projects are difficult to predict. We are not currently aware of plans for specific major highway/road projects in this unit that would potentially impact lynx habitats and increase future habitat loss or fragmentation. Other potential sources of future habitat loss and fragmentation include recreation, minerals/energy development, and forest/ backcountry roads and trails; these are all considered second tier anthropogenic influences (ILBT 2013, pp. 78-85) that are unlikely to exert population-level influences, despite potential impacts to individual lynx.

Other Factors: *Connectivity/immigration* – This geographic unit is not directly connected to lynx populations in Canada or elsewhere in the DPS range, although lynx released into Colorado

have dispersed northward into and through this unit. There is little evidence of intermittent immigration into this unit during past irruptions of lynx from Canada, as has been documented in other parts of the contiguous U.S. Nonetheless, as elsewhere in the DPS, immigration may influence the persistence of resident lynx in this unit. If continued climate warming or other factors further reduce the chances that dispersing lynx will reach this unit and contribute to its demographic and genetic health, either through habitat loss and fragmentation in potential dispersal corridors or declines in the amplitude of northern hare and lynx population cycles, the likelihood that the unit will support resident lynx in the future may also decline. However, as in Unit 3 above, because we lack information of historic, recent, and likely future rates of immigration and its contribution to the persistence of lynx populations in this geographic unit, impacts of potentially reduced future immigration are difficult to project and are largely speculative at this time.

Conclusion

After reviewing the scientific literature and evaluating the factors that may influence lynx persistence in this unit, we concur with the experts' conclusion that this geographic unit is the least secure in the DPS. We find that conditions for lynx in this unit are naturally marginal, its historical or current ability to support a persistent resident lynx population are questionable, and that continued climate warming and associated impacts are likely to further diminish its already limited ability to support resident lynx. We conclude that it may continue to occasionally/ intermittently support a small number of resident lynx and some reproduction over the short term (through 2025), but that it is very unlikely to support a persistent resident population over that time frame, even less likely that it will do so at mid-century, and highly improbable that this geographic unit will support resident lynx by the end-of-century.

5.2.6 Unit 6 - Western Colorado

Expert Projections of Lynx Persistence

The experts we consulted suggested an initially high probability of persistence in Colorado, declining gradually with increasing uncertainty through the end of the century. Experts predicted near-term (year 2025) persistence probabilities of 60 percent to 100 percent (median = 90 percent), and mid-century persistence at 50 percent to 85 percent (median = 80 percent). Experts predicted end-of-century persistence probabilities of 20 percent to 70 percent for this unit, with a median of 50 percent, by 2100 (Figure 13).

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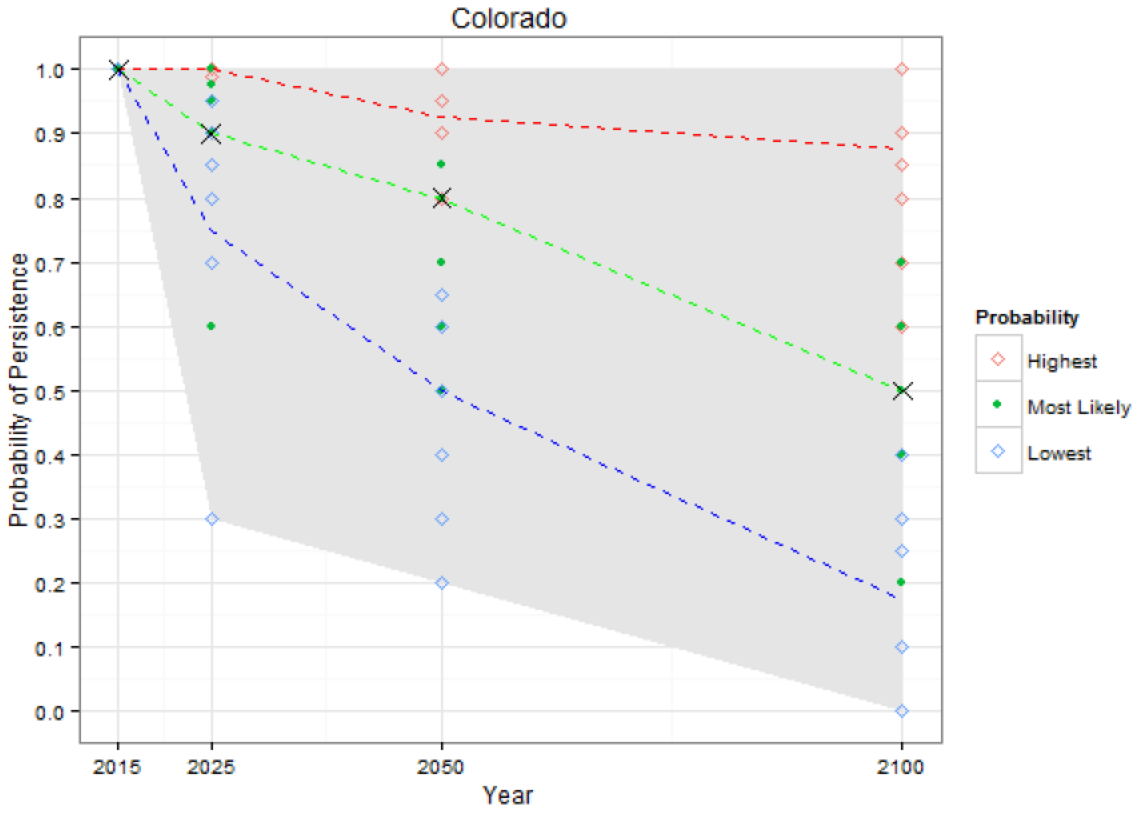


Figure 13. Expected probability of persistence for the Western Colorado Geographic Unit at present, 2015, and in 2025, 2050 and 2100.

Some experts indicated that beetle kill and fire could potentially create poor habitat conditions in large areas of this unit by mid-century, but that regeneration after these impacts could result in good lynx/hare habitats. Others expressed uncertainty about whether fire and insect impacts would be temporary or permanent, especially considering climate change and the potential for conversion from boreal/subalpine forests to other forest types. Although 8 of 10 experts graphed 50 percent to 70 percent probability of persistence by 2100, during subsequent discussions, several expressed greater uncertainty about whether resident lynx will persist in the unit at the end of the century. Higher-quality lynx habitat occurs primarily in two areas and is patchily-distributed. Lynx in this unit may occur as several smaller, relatively isolated subpopulations, which are likely more vulnerable to stochastic events. This unit's relative isolation may limit exchange with other lynx populations, increasing the likelihood of genetic drift and reducing the chance of demographic rescue or recolonization if lynx in the unit become extirpated. There was discussion about whether ski areas may affect daily movements of lynx, and hares may be declining in ski areas. Ski areas tend to expand and may, therefore, have larger impacts on lynx in the future. There is some evidence of lynx using ski areas in summer months but avoiding them during the ski season. It is uncertain whether ski areas may affect genetic connectivity within the Western Colorado geographic unit. Two-thirds to three-quarters of the lynx in this unit are in the southern portion of the range in the San Juan Mountains. There is a large area

(Weminuche Wilderness) in Colorado that has not been well surveyed for lynx, so it is possible that lynx also could be using that area.

Service Evaluation of Factors Potentially Influencing Future Conditions

Regulatory Mechanisms - Regulatory mechanisms for the conservation of lynx in the Southern Rockies consist of seven amended USFS management plans in south-central Wyoming and Colorado. We concluded that the Southern Rockies Lynx Amendment substantively reduced the inadequate regulatory mechanisms by addressing the major adverse impacts of Forest Service land management on lynx (USFWS 2008b, p. 70-71). Lynx habitat on all other ownerships makes up the remaining 15 percent of lynx habitat in Colorado, of which, only five percent is in Federal ownership. Other ownerships include state, county, municipal, etc., and private lands. Some BLM resource management plans have not been amended to include conservation specifically for lynx. Lynx habitat on BLM ownership mostly consists of narrow forest extensions connected to larger blocks of habitat on adjacent USFS lands. Generally these extensions are insufficient on their own to support a lynx home range. However, the Gunnison Field Office is the only BLM unit that contains sufficient habitat to map and identify LAUs.

The State of Colorado manages lynx as a State endangered species C.R.S. 33-2-105, prohibiting take of the species with exceptions for protection of human life (C.R.S. 33-6-205 and incidentally during depredation management (not caused by lynx) [C.R.S. 33-6-207].

Climate Change - ILBT (2013, p. 61) – "Climate change generally is expected to result in warmer winters, earlier spring snowmelt, and a reduction in the extent of snow cover in the Southern Rockies. McKelvey *et al.* (2011, entire) used a variety of climate models to predict snow depth and the persistence of spring snow across the western United States. The models predicted an overall decline in persistent snow of 40 percent, but large areas of persistent snow would continue to be retained late in the 21st century, including the high elevations of Colorado."

"All of the climate models under all representative concentration pathways (RCPs) project that Colorado's climate will warm substantially by 2050. Under RCP 4.5 (medium-low emissions scenario), Colorado's annual temperatures are projected to warm by +2.5°F to +5°F by mid-century relative to 1971–2000 observed baseline. Under RCP 8.5 (high emissions scenario), Colorado's annual temperatures are projected to warm by +3.5°F to +6.5°F by mid-century. Summers are projected to warm slightly more than winters under both RCPs. Looking beyond the 2050-centered analysis period, the warming trend is projected to continue into the late-21st century under all RCPs except RCP 2.6. By the period centered on 2070 (2055–2084), the projected warming in Colorado annual temperatures under RCP 4.5 is +2.5°F to +6.5°F relative to the 1971–2000 baseline. Under RCP 8.5, the projected warming is +5.5°F to +9.5°F relative to the 1971–2000 baseline." [Lukas *et al.* 2014, p. 61]

An analysis of projected 21st century temperature trends as a function of elevation in the Northern Hemisphere mid-latitudes from CMIP5 models shows more warming at higher

elevations during winter, particularly in the daily minimum temperature (Rangwala *et al.* 2013 [cited in Lukas *et al.* 2014, p. 63]). "However, as discussed in Section 3, the global climate models do not represent the topography of Colorado very well, so it is difficult to discern whether the warming projected for the higher elevation regions (>10,000') in the state is substantially different from that projected for lower elevations" (Lukas *et al.* 2014, p. 63).

On average, the climate models indicate a seasonal shift in precipitation for Colorado, with increasing winter precipitation, and in some areas a decrease in late spring precipitation (Lukas *et al.* 2014, p. 65).

Vegetation Management - In the past decade, vegetation management within lynx habitat has been predominantly salvage of dead and dying timber caused by a mountain pine beetle infestation in the northern part of the state (generally north of Interstate 70), and a spruce bark beetle infestation south of the interstate. Salvage operations may temporarily impact understory regeneration, if present, reducing the capacity of the stand to support higher snowshoe hare densities. Assuming the existing US Forest Service plans retain their current conservation framework, USFS lands should continue to provide sufficient habitat for lynx through the end of the century.

Vegetation management on non-Federal ownerships within lynx habitat is unlikely to cause significant concern for lynx conservation in Colorado through the remainder of the century.

Wildland Fire Management - "It is generally acknowledged that in the Southern Rocky Mountains fire suppression has altered historical vegetative patterns. This effect has been most pronounced within vegetation communities where fire regimes are of low intensity or mixed severity. It is generally agreed that spruce-fir habitats have been little affected by fire suppression because the fire regimes within this type tend to be stand-replacing events occurring at long intervals (100+ years). Depending on the moisture regime, large stand-replacing fires within lynx habitat may produce young age class snowshoe hare habitat after approximately 10-30 years. Although this vegetative condition may provide some high quality snowshoe hare habitat, mature forests are also very important as winter foraging habitat." (USFS 2008, p. 36)

Habitat Fragmentation - Sources of current habitat fragmentation include high-speed high-volume highways, high mountain valley developments, vegetation management, ski/recreation area development, and wildland fire. Currently, only vegetation management on USFS lands is managed to limit lynx habitat fragmentation. Highways are likely to be expanded to accommodate increasing traffic volume as mountain valley communities continue to develop and expand. While these linear features already exist on the landscape, widening of the cleared right-of-way, as well as lynx behavioral avoidance of highway rights-of-way because of increasing traffic volume reduces available habitat function for lynx. Many ski areas in Colorado are located within lynx habitat and will likely be expanded in the future through permanent removal of vegetation to create conventional ski runs, reducing tree density and clearing understory vegetation to create glade conditions, reduces lynx habitat. The magnitude of

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fragmentation caused by these sources has not been quantified, but is unlikely to remove enough lynx habitat to eliminate the possibility of lynx persistence in Colorado.

Conclusion

Based on the best scientific information available, the Core Team retains some uncertainty about the fate of lynx in western Colorado. Our uncertainty stems primarily from the historic record of lynx in Colorado, where the presence of lynx is questionable or non-existent for several decades. In addition, one of the metrics for our assessment is productivity (pregnancy rate), which was low for this population relative to the other units (except the GYA, for which we had no data). Despite these uncertainties, we anticipate lynx populations to persist through the end of the century. Our conclusion about their persistence relies on consistent reproductive success.

We have considered the future of lynx in Colorado in the absence of the protections offered by the ESA. We believe that as long as the current regulatory mechanisms provided by the State of Colorado to prevent take of lynx, and the USFS SRLA conservation framework remains in place, lynx are likely protected from take, and their habitat requirements likely met in a significant majority of the available habitat within the state. Projected future climate warming is likely to result in reduction of available habitat and increased fragmentation resulting in larger areas of non-habitat between habitat blocks. Vegetative changes caused by climate change will likely result in less habitat in private and BLM ownership, due to the anticipated upslope shift in vegetation that supports snowshoe hares and lynx.

The movement capability of lynx is well documented, and lynx in Colorado will likely continue to explore the landscape and exploit the available habitat despite gaps between functional habitat blocks. Discussions during our expert elicitation reflect concern that ski area and base area developments could affect daily movements of lynx. The discussions revealed that ski area related development, including residential development of base areas, may limit lynx's ability to fully exploit habitats year round. Colorado is isolated from source populations in the northern part of the range relative to the other units, which injects uncertainty about the possibility of genetic drift from mid-century onward. Our expert elicitation documented some uncertainty whether ski areas may affect genetic connectivity within the unit. However, the Core Team is less concerned about this particular issue because we cannot foresee the development of barriers that would prevent lynx from accessing all available lynx habitat in the future.

Chapter 6: Synthesis

This section synthesizes the needs, current condition, and likely future condition of the Canada lynx in the contiguous U.S. DPS with respect to the conservation biology principles of representation, redundancy, and resiliency. Its purpose is to provide an understanding of the range-wide status of this DPS that is as clear as possible given the unavoidable uncertainties involving demography and long-term threats.

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Needs

Throughout the species' range, the lynx is a habitat and prey specialist requiring boreal forests with dense horizontal cover, long winters, and deep, fluffy snow, which gives it a competitive advantage for exploiting its primary prey, the snowshoe hare. Lynx in the contiguous U.S. have ecological requirements similar to those of lynx in Canada and Alaska, and throughout the species' range hare abundance is the primary driver of lynx population dynamics. However, the DPS is at the southernmost margin of the species' range, where boreal forests transition to temperate conifer and hardwood forests, and where snow conditions and hare abundance generally become less favorable with decreasing latitude. Because of this, habitat is less extensive and generally more fragmented within the DPS range than in the core of the species' range in Canada and Alaska. As a result, lynx in the contiguous U.S. are naturally less abundant and more patchily distributed than in the core of the range. Maintaining connectivity between lynx populations in Canada and the DPS is thought to be important; however, whether and if so to what extent the demographic and/or genetic health of DPS populations relies on periodic immigration from Canadian populations remains uncertain.

Current Conditions and Threats

Resiliency, the ability to withstand stochastic disturbance events, and redundancy, the ability to withstand catastrophic events, are currently exhibited in the lynx DPS by the persistence of individual lynx populations and their broad distribution across the geographic scope of the DPS. Available information indicates that five out of six geographic units in the DPS (all but the GYA) contain resident breeding lynx populations. Although we have no reliable population-size estimates for any of the geographic units, Northern Maine (Unit 1) is believed to currently have habitat to support the largest resident population in the DPS, perhaps 500-1,000 individual lynx. In Northeastern Minnesota (Unit 2), a resident population of perhaps 50-200 lynx occupies the Arrowhead Region of the State. Northwestern Montana and northeastern Idaho (Unit 3) continue to support resident lynx, thought to number 200-300, although a small subpopulation in the Garnet Mountains on the southern periphery of this unit may have been extirpated recently. In North-central Washington (Unit 4), recent extensive wildfires have temporarily reduced the amount of high-quality lynx habitat and may have caused a decline in lynx numbers there from perhaps 100 before the large fires to half of that currently. The Greater Yellowstone Area (GYA, Unit 5) is thought to have historically supported a small resident population; however, resident lynx have not been documented recently in this unit. Since the release of Canadian and Alaskan lynx in 1999-2006, resident lynx currently occupy western Colorado (Unit 6). The apparent long-term (historical and current) persistence of resident lynx populations in at least four of the six geographic units (Units 1-4) and the absence of reliable information indicating that the current distribution and relative abundance of resident lynx are substantially reduced from historical conditions suggest the historical and recent resiliency of lynx populations in the DPS. The large sizes and broad geographic distributions of the areas occupied by resident lynx populations likewise indicate adequate historical and current redundancy in the DPS to preclude its extirpation because of catastrophic events.

Representation, the ability of a species to adapt to changing environmental conditions over time, is characterized by the breadth of genetic and ecological diversity within and among populations (Lynx SSA Team 2016, p. 25). Information provided by lynx experts and geneticists indicates high rates of dispersal and gene flow and, therefore, generally low levels of genetic differentiation across most of the species' range, including the DPS (Lynx SSA Team 2016, pp. 12-14, 55-56). Hybridization with bobcats has been documented but is not considered a substantial current threat to the DPS (Lynx SSA Team 2016, p. 13). Despite differences in forest community types and topographic/elevation settings, lynx across the range of the DPS occupy a similarly narrow and specialized ecological niche defined by specific vegetation structure, snow conditions, and the abundance of a single prey species. Thus, lynx naturally have little ability to adapt to changing environmental conditions (i.e., shift to other forest habitats, snow conditions, or prey species). However, although some small populations may have become extirpated recently, resident lynx in the DPS remain broadly distributed across the range of ecological settings that seems to have supported them historically in the contiguous U.S. There are no indications of current threats to the genetic health or adaptive capacity of lynx populations in the DPS, and the current level of representation does not appear to represent a decrease from historical conditions.

The primary threat identified at the time of listing, lack of regulations protecting lynx habitat on Federal lands, has been largely addressed by formal and binding amendments or revisions to most Federal land management plans within the DPS range. Although uncertainty remains about the efficacy of this improved regulatory framework, Federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands. Most Federal lands, which constitute 64 percent of lynx habitat evaluated in this SSA, are found in the western U.S.

Other stressors affect lynx in one or more geographic units. For example, in northern Maine, where most high-quality lynx habitat occurs on private commercial timber lands and is the result of past timber harvest, changes in State forestry regulations (the Maine Forest Practices Act of 1989) that govern private forest management may currently be causing decreases in habitat quantity, quality, and distribution, and in lynx numbers (also see *Future Conditions and Threats*, below). The lack of binding lynx conservation commitments on private lands may exacerbate this risk to current lynx habitats in Maine. However, the current amount and distribution of high-quality lynx and hare habitats created in Maine by past timber harvest is thought to be several times higher than the likely natural historical condition. In North-central Washington, recent large-scale wildfires have resulted in the temporary loss of nearly 50 percent of lynx habitat, likely reducing this unit's current lynx population and potentially compromising its current ability to support a resident population until habitats recover. Increased wildfire activity also has impacted lynx habitats in the other western geographic units (Northwestern Montana/Northeastern Idaho, the GYA, and Western Colorado), but the extent to which it may have influenced the current condition of lynx populations in those units is uncertain.

Climate change is occurring at a global and, thus, a DPS-wide scale. Climate warming has reduced snow amount, duration, and quality (in terms of conditions favorable for lynx), it has

been linked to increased frequency, size, and severity of wildfires and forest insect outbreaks, and it likely has already resulted in some changes in forest vegetative communities. Climate warming has also been linked to changes in the amplitude, periodicity, and synchronicity of northern hare population cycles, which could alter the timing and magnitude of irruptions of lynx from Canada into the contiguous U.S. If lynx populations in the DPS depend on immigration from Canada which is no longer occurring or has been substantially reduced relative to historical conditions, population declines and an increased likelihood of extirpation among resident populations would be expected. However, whether, and if so to what extent, these climate-mediated factors have influenced current lynx numbers, other demographic parameters, and/or habitat quality and distribution is uncertain and has not been quantified across the range of the DPS or in individual geographic units. Despite uncertainty regarding its influence over current conditions for lynx, climate modeling and expert opinion concur that continued climate warming will adversely impact lynx in the DPS in the future (see below).

Future Conditions and Threats

Overall, our evaluations of the scientific literature and expert input suggest that resident lynx populations in each of the geographic units are likely to be smaller and their distributions reduced in the future. These anticipated declines are most likely to be influenced by projected loss and increasing fragmentation and isolation of boreal forests and favorable snow conditions resulting from continued climate warming and related impacts (e.g., increased wildfire and forest insect activity, diminished hare populations; Lynx SSA Team 2016, p. 58). Forest management on private lands that lack lynx conservation commitments may also contribute to future declines, particularly in northern Maine. In each geographic unit, the probability that resident lynx populations will persist is expected to decline through the end of the century, with uncertainty about the rate of decline increasing with time from the present. The loss of resident lynx from one or more geographic unit would represent reduced future resiliency, redundancy, and representation within the lynx DPS.

The resiliency of lynx populations in individual geographic units is the primary determinant of the future viability of the lynx DPS. Our analyses and expert predictions suggest a declining probability of persistence (loss of resiliency) for each of the geographic units within the DPS throughout the rest of this century (the analysis did not extend beyond 2100). Projected climate warming is expected to exert the greatest influence on the resiliency of individual populations, and thus continued presence of resident lynx in each geographic unit. Climate models project that boreal forests and snow conditions favorable for lynx at the southern periphery of the range will retreat northward and upslope with continued warming, further fragmenting and diminishing the quality of lynx and hare habitat within the DPS. Although uncertainty remains regarding the timing, extent, and biological consequences of such impacts, as habitat conditions decline, hare populations will decline and lynx mortality rates are likely to increase and reproductive rates decrease. As snow conditions become less favorable, competitors (e.g., bobcats) are likely to outcompete and displace lynx. This in turn will reduce lynx abundance and density within populations, making populations more susceptible to stochastic events.

The loss of any geographic units would also reduce the level of redundancy and could diminish representation within the DPS. With regard to redundancy, however, we find that none of the five geographic units that currently support resident lynx is vulnerable to extirpation from a single catastrophic event. Given that, we conclude that the DPS as a whole is not vulnerable to extirpation from a catastrophic event (i.e., we find that there is a zero probability that a single catastrophic event could result in extirpation of resident lynx from any of the five geographic units that currently support them and, therefore, a zero probability of catastrophic extirpation of the entire DPS). We recognize that a sequence of discrete but spatially-clustered catastrophic events in lynx habitats over a short time could increase the potential for functional extirpation in one or more of the individual geographic units (especially the possibility of additional large wildfires in north-central Washington), thereby reducing redundancy within the DPS. However, as long as resident lynx remain geographically well-distributed in one or more units within the DPS, extirpation of the DPS from a single catastrophic event is very unlikely.

With regard to representation, although some lynx populations in the DPS units are demographically isolated from each other and the level of interaction between others is uncertain, there seems to be little risk of significant genetic drift. This is because of the currently-observed and likely future high level of gene flow across most of the lynx's continental range, the species' well-documented dispersal capability, the current and likely future absence of significant barriers to dispersal between Canada and the DPS, and continued connectivity between most parts of the DPS and lynx populations in Canada. Furthermore, based on expert input, we conclude that there is no indication that the relatively low level of genetic diversity currently observed among lynx populations is likely to reduce DPS viability in the future (USFWS 2016, p. 51). This information suggests the current and likely future relative genetic health of the DPS.

How the potential loss of resident lynx from one or more geographic unit may affect representation within the DPS in terms of ecological diversity is uncertain. Despite similarities in the fundamental components (vegetation, snow conditions, and hares) that define the ecological niche of lynx DPS-wide, differences in habitats and how lynx use them are apparent. For example, snow depth that seems to demarcate a boundary between lynx and bobcat occupancy in Maine (270 cm/yr) is almost twice that observed in Minnesota (140 cm/yr]), and lynx in some parts of the West select mature forest stands, particularly in winter, while in other parts of the DPS, young regenerating stands are most important. The loss of resident lynx from any of the geographic units could result in the loss of behavioral and potential future genetic adaptations to the climate-mediated changes now occurring and likely to continue into the future at the southern edge of the lynx range. Such potential adaptability to diminished snow conditions, increasingly patchy and isolated boreal forests, and reduced hare abundance may be important to the taxon as a whole faced with a rapidly changing climate.

Given the high percentage of Federal land ownership in the West, regulatory commitments that these lands will continue to be managed in accordance with lynx conservation principles, and the existence of potential high-elevation climate refugia to which lynx habitats and some lynx might move, the western geographic units (Units 3-6) may be more likely to support resident

lynx longer under projected continued climate warming. Nonetheless, it is unlikely that any management actions can abate the long-term northward and upslope retreat of boreal forests and diminished snow conditions projected by climate models. Further, the size, frequency, and intensity of wildfires and forest insect outbreaks are expected to increase with continued climate warming, particularly in the western portion of the DPS, although we do not anticipate such events in-and-of-themselves are likely to cause the permanent loss of breeding lynx populations in any geographic unit.

Although projections of climate-mediated losses of boreal forests and favorable snow conditions suggest impacts to lynx and hare populations throughout the DPS, persistence of resident lynx in Maine and Minnesota may be relatively lower than the western geographic units given the smaller percent of Federal lands and the absence of associated regulatory commitments to lynx conservation, and the lack of potential elevational refugia. Additionally, as noted above, changes to regulations governing timber harvest on private forest lands in Maine are unlikely to maintain the current historically-high amount and distribution of good lynx habitat or the current large population of resident lynx. These changes, which may affect over 90 percent of lynx habitats in northern Maine, are projected to result in substantial declines in habitat quality and distribution, and lynx numbers, over the next 10-30 years, primarily through restrictions on clearcutting and the proliferation of partial harvesting, which are detrimental to snowshoe hare and lynx needs. On private forest lands, energy development (wind energy, mining), rapid turnover in ownership and parcelization of forest land, and uncertain forest markets may also reduce the future quality and quantity of lynx habitat.

DPS Viability

Although all five geographic units that currently support populations (all units except the GYA) are expected by lynx experts to continue to do so through mid-century, only one (Northwestern Montana/ Northeastern Idaho) has an estimated probability of persistence greater than 50 percent (i.e., persistence more likely than not) by the end of the century (Lynx SSA Team 2016, pp. 36-49, 58). The experts we consulted projected that all the other geographic units have a 50 percent or greater probability of functional extirpation (i.e., no longer capable of supporting resident lynx populations) by the end of the century, with a moderate to high likelihood that resident lynx will be lost from two to four units by then. Potential elevational refugia may increase the likelihood of persistence in western units, although uncertainty remains about the timing of warming-driven upslope movements of habitats and snow conditions and the extent to which hare and lynx populations may follow them. Regardless, future lynx habitats throughout the DPS range are likely to be smaller and more fragmented, and geographic units that are already relatively isolated from other lynx populations are likely to become even more isolated in the future. Despite the lack of elevational refugia, lynx may also persist at the end of the century in Maine and Minnesota, depending on the timing and severity of climate change effects and, in Maine, on trends in development and private forest management. Uncertainty increases at mid- to late-century concerning the timing and extent of various stressors that will affect lynx and hare habitat and snow regimes, especially those related to climate change. However, review of the best available science in concert with input from lynx experts suggests that the probability of

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the persistence of resident breeding populations will decline in all geographic units, with the negative DPS-wide trajectory continuing to the end of the century, and (with no evidence to the contrary) beyond that time frame.

Our evaluation generally concurs with the expert input we received. We believe that lynx populations and habitats in the DPS will decline over time largely as a result of continued climate warming and associated impacts, which are likely to exacerbate the potential adverse effects of other factors (e.g., forest management, competition from other hare predators). Because resident lynx populations in all geographic units that currently support them are expected to be smaller and more fragmented and isolated in the future, each geographic unit and the DPS as a whole will be less resilient in the future. Our analyses and expert input suggest that resiliency will likely be adequate to foster persistence of resident lynx through mid-century in most of the five geographic units that currently support them. However, we believe it is very unlikely that resident lynx populations will persist through the end of this century in all of the geographic units that currently support them. That is, we believe that resiliency will be substantially diminished because of reduced population sizes and distributions throughout the DPS, with resulting extirpation of resident populations from two to three (of five) units more likely than not by the end of the century.

We conclude that the functional extirpation of resident lynx populations from one or more geographic unit would demonstrate a loss of resiliency, reduced redundancy, and, possibly, reduced representation within the DPS. The probability of losses in resiliency, redundancy, and representation puts the Canada lynx DPS at increasing risk of extirpation through the end of this century.

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DRAFT

From: (b) (6) P.I.I.
To: McCollough, Mark
Subject: Re: Any chance I could talk with you re. lynx and hares in the next day?
Date: Monday, February 27, 2017 10:02:42 PM

Mark,

I have signed a strict confidentiality agreement that restricts me from discussing the lynx SSA with anyone. If you have specific questions about our partial harvesting and shelterwood hare densities based on the research FWS has funded with us, I would be glad to answer those questions specifically and will provide my scientific interpretations without reference to the Draft Lynx SSA, other reviews, or the SSA process. I will be working at home tomorrow and my home number is (b) (6) P.I.I. . Nate Webb from IFW called me to discuss hares, partial harvest and shelterwoods with me prior to my receiving or reviewing the Lynx SSA document, but I have not seen IFW interpretations based on the data and thus, can not comment on the accuracy of the interpretations that I shared with them. I can only share the same interpretations of my lab's data with you and hope that will meet your needs.

I look forward to chatting about our research results.

Dan

Cheers- Dan

Daniel J. Harrison
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On Mon, Feb 27, 2017 at 1:19 PM, McCollough, Mark <mark_mccollough@fws.gov> wrote:

> Dan: Is there a chance that I could talk with you via phone today or tomorrow? MDIFW provided comments on the lynx SSA and discussed their concerns with the regional office. Their hypothesis is that your data show increasing numbers of hares in partial harvested stands, therefore lynx will be fine in the future. I talked to Paul Phifer today and he would like your take on this idea (perhaps you will address in the peer review comments?).
>
> I am leaving on Wednesday for Denver for the meeting concerning the lynx listing.
>
> I can give you a call, but don't have your cell phone number.
>
> Thanks, Mark
>
> --
> **PLEASE NOTE THAT OUR OFFICE ADDRESS AND PHONE HAVE CHANGED**

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From: Erb, John D (DNR)
To: Smith, Tamara
Subject: RE: accidentally trapped lynx
Date: Monday, December 11, 2017 12:36:58 PM
Attachments: Incident Report 17029282 - details form.xls
Incident Report 17029282 - MNCON00E1.pdf

Hi Tam:

The official ICR is attached for your records. Also attached is a form we use to record more trap details. Appears he set the snare "on bobcat tracks along a creek", which makes me suspect he may just not have been good at distinguishing lynx and bobcat tracks…..though entirely possible a lynx and bobcat used same trail. Unfortunate, but the first one in I think 3 years now.

John

From: Smith, Tamara [mailto:tamara_smith@fws.gov]
Sent: Monday, December 11, 2017 8:55 AM
To: Hansen, Nancy (DNR) <nancy.hansen@state.mn.us>
Cc: Erb, John D (DNR) <john.erb@state.mn.us>; Baker, Richard (DNR) <richard.baker@state.mn.us>; Olfelt, Dave P (DNR) <dave.olfelt@state.mn.us>; Aarhus-Ward, Angela (DNR) <angela.aarhus-ward@state.mn.us>; Cornicelli, Lou (DNR) <lou.cornicelli@state.mn.us>; Abraham, Jason (DNR) <jason.abraham@state.mn.us>; Rusch, Tom P (DNR) <tom.rusch@state.mn.us>
Subject: Re: accidentally trapped lynx

Hi John - Thank you for the email. Please let me know if you find out more information. Do you know what the target animal was?

Thanks,
Tam

On Fri, Dec 8, 2017 at 10:40 PM, Hansen, Nancy (DNR) <nancy.hansen@state.mn.us> wrote:

> If this is the one reported by the Finland area officer, the DNA sample will be collected by USFS on Monday at our Enforcement office in Two Harbors.
>
> Thank you,
> Nancy Hansen
> Area Wildlife Manager
> Two Harbors
>
> ---
>
> **From:** Erb, John D (DNR)
> **Sent:** Friday, December 8, 2017 3:34:19 PM
> **To:** Baker, Richard (DNR); Smith, Tamara; Olfelt, Dave P (DNR); Aarhus-Ward, Angela (DNR); Cornicelli, Lou (DNR); Abraham, Jason (DNR)
> **Cc:** Hansen, Nancy (DNR); Rusch, Tom P (DNR)
> **Subject:** accidentally trapped lynx

FYI, per our 'official' DNR reporting protocol, this is to alert you that a lynx was accidentally trapped/killed on 12/1/17 in Lake County, N47 33.232 W91 22.37411. I was out some since then, so sorry for some delays in this notice. I do have some details (reportedly a female, taken in a snare, trap set was legal), but am awaiting a copy of the complete ICR and will then forward that to you. Nothing specific you need to do, just FYI.

Also FYI, USFS already has a DNA sample for their analysis.

John Erb

Furbearer/Wolf Research Scientist

Minnesota DNR

Forest Wildlife Populations and Research Group

1201 E. Hwy 2

Grand Rapids, MN 55744

218-328-8875

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Tamara Smith
U.S. Fish and Wildlife Service
Minnesota Wisconsin Field Office
4101 American Boulevard East
Bloomington, MN 55425
952-252-0092, Ext. 219
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DEPARTMENT OF NATURAL RESOURCES
INCIDENT REPORT

ICR# 17029282	AGENCY ORI# MNCON00E1	JUVENILE:

INCIDENT

Reported: 12-01-2017 1845
Committed Start: 12-01-2017 1400 **Committed End:** 12-01-2017 2153
Title: Evidence **How Received:** Phone
Short Description:
Incidental Lynx turned in.
Summary:
Incidental lynx in snare turned in at site. Green tag: 437090
Location(s)
Address: **City:** Lake County **State:** MN **Zip:** **Country:**

OFFICERS

Officer Assigned: Schottenbauer, David **Badge No:** 492 **Primary:** No

NAMES

Involvement: Other **Name:** (b) (6) P.I.I.
Age: 44 **Sex:** **Race:** **Height:** 0 **Weight:** 0
Address: (b) (6) P.I.I. **City:** (b) (6) **State:** (b) **Zip:** (b) (6) **Country:**

EVIDENCE

BarCode: 0000000023596 **Item Type:** Endangered Species **Bin:** David Schottenbauer Storage Bin
Description: Incidental trap (snare) turn in. - Ball lock tag #437090
Location
Address: (Public) **City:** Lake County **State:** MN **Zip:** **Country:**
Name(s)
Last Name: (b) (6) **First:** (b) (6) **Middle:** (b) (6)

Supplemental Report

ICR: 17029282 **Last Modified:** 12-05-2017 1230
Title: Lynx **Created By:** David Schottenbauer

Took a call from (b) (6) P I I stating that he had accidentally gotten a lynx in a snare. I told him not to touch it, and I would come to the site to retrieve the lynx.

That evening I met Jeffery and we went to the site. I found the lynx in the tagged snare (Appeared to be legally set). (b) (6) P I I and I had spoken of Lynx Zone rules for snaring prior to his setting snares.

Lynx was seized and snare was returned to (b) (6) P I I .

Per policy a Lynx Trapping Incident Form was completed and included in this ICR.

Lynx is stored at Enforcement freezer in Two Harbors, and Wildlife has been notified. Wildlife has requested DNA samples, and they will have access for those.

Lynx Trapping Incident Form

Observer: CO David Schottenbauer (K236 **ICR # :** **17029282**

Date: 12/1/2017

Location Data

GPS coordinates: N47 33.232 W91 22.37411

Location Description: Snake Trail in Lake County about 1.6 miles west of HWY 1

Animal Data

1) Sex (if known):	**M**	**F**	**Unk**			
2) Status	**Dead**	**Alive/released**	**Alive/rehab**	**Euthanized**		
3) Catch Area	**neck**	**torso**	**L / R front foot**	**L / R hind foot**	**other**	
4) DNA sample?	**tissue**	**hair**	**blood**	**urine**	**scat**	**none**
5) Any photos taken?	**Y**	**N**				

6) Description of any injuries Caught in legal snare on creek bottom.

Trap/Set Data

Foothold:

1) size/model:
2) chain length:
3) offset jaws? Y N
4) padded jaws? Y N
5) # swivels:

Bodygrip

1) size/model:
2) baited cubby OR unbaited trail set
3) On ground OR above-ground
If above, how far?
4) if cubby, how far trap recessed

Snare

1) cable diameter 1/8 inch
2) lock brand unknown
3) loop diameter 8.5 inches
4) height loop off ground 9 inches
5) any loop stops? Y N
6) snare length 24 inches total cable

1) Was bait/lure used? If so, specify type. Set on bobcat tracks on frozen creek.
2) If bait used, approximate distance between bait and trap None seen/used.
3) For snares/footholds, did animal have 1) free movement around trap anchor, or 2) was it entangled in woody vegetation?
4) Approximate number of hours since last trap check: Less than 18 hours

Brief summary of trap set details: Appeared to be a legally set snare.

Additional Comments: Trapper took the time to verify Lynx zone rules with me before setting.